DESIGN WATER
TECHNOLOGIES

Field Tips for Cleaning Wells. & Engineering Specifications
Includes mineral scale, iron bacteria, bentonite, and silts

Note: The regular type can be used for Engineering Specifications and the italicized text more as comments.

The yield of a well may decline in screened wells or open boreholes due to, 1. mineral scale deposits. 2. slime or iron oxidizing bacterial deposits. Corrosion and odor problems may also be caused by various forms of bacteria. 3. silt infiltration into the borehole area causing a reduction in permeability directly around the well screen or sand/silts filling into the well. 4. reductions of static levels in Water Table Aquifer reducing Transmissivity. ALWAYS compare Specific Capacity (SC) information to make sure it's the well yield that has declined. The proper identification of a problem leads to better solutions. Our laboratory deals specifically with water problems and can provide information on mineral scale potential, corrosion, bacterial analysis for slime potential, odor, and corrosion problems, including identification and recommendations for treatment. We also provide sub consulting field services on the job site. Check out our web site, for information on products and services.

Unconsolidated formations: For this purpose, this is categorized as a formation that can not stand open during pumping and requires some form of screening device, i.e., continuous slot screen, louver screen, bridge slot screen, or slotted pipe. The original design may or may not have included a filter pack design. IF a filter pack design was used, ALWAYS check the distance from the OD of the screen to the borehole diameter. If that distance is greater than 5", any redevelopment is limited because of physical inaccessibility to the edge of the borehole. If you have questions, please call or e mail our Technical Service Department.

Consolidated formations: This is categorized as a formation that can stand open during pumping. Any reduction of SC can be caused by mineral deposits, slime or iron bacteria, or physical plugging. These types of aquifers can include cemented sandstone, fractured or cavernous limestone, fractured hardened formations such as shale, granite, coal seams etc. Always measure the depth of the well and compare to the original. Any soft and caving formation material will have a tendency to fill in close to the top of the caving zone. Always review the drillers log or any geophysical logging information available.

Some wells may have casing liners to prevent pump problems with falling debris into a well. Beware, falling debris into the annulus between the casing and the borehole may reduce pumping capability. This debris may or may not be affected or dissolved by any chemistry. The liner may have to be removed prior to physical removal of this debris. The well may then be treated, if necessary.

If silts/clays are suspected in a reduction of yield, the usage of surfactants such as "Mud Buster" can be used . See Option 3, "Physical Debris", and the "Mud Buster" section after the Engineer's Specification Sheet.

Lab services shall be completed to determine problems due to the chemistry of mineral deposits and corrosion potential, as well as bacterial analysis for slime plugging, iron bacteria, corrosion, and odors. Sample bottles are available from Design Water Technologies (DWT) or your local DWT distributor. These bottles are pre labeled to the laboratory and are complete with instructions for sample times, handling, etc. The calculation for sample times are available from our web site in the "Lab Services" section or call DWT for directions. Make sure the well has sat for a minimum of 24 hours prior to sampling. For bacterial testing, take the sample before the calculated timeframe for "Casing Storage". A second sample shall be taken at a minimum of 60 minutes later as an "Aquifer Sample" to determine the potential for well problems verses aquifer problems.

Physical information prior to pulling the pump and well treatment

Diameter and length of all casing and screens, total depths, etc. should be recorded. Any previous information regarding Static Water Level, Pumping Water Level at a given pumping rate, and Specific Capacity (SC) should be obtained for comparative analysis prior to any treatment. Be aware, the SC will be lower if the comparison pumping rate is higher. Conversely, if the comparison pumping rate is lower, the SC may be higher. Compare the percentage of decline of SC to determine the approximate percentage of blockage. IF the SC is higher and the pumping rate is lower may indicate a pump maintenance issue.

A pumping test shall be completed prior to treatment and removal of the pump. This pumping test shall record Static Water Level prior to startup, Pumping Water Level, and Specific Capacity (SC) in GPM per foot of drawdown. This test shall be conducted for a period of time to eliminate the effects of casing storage (a minimum of 60 minutes) and provide adequate drawdown data from the aquifer. The time for pumping shall be consistent for comparing SC in the "Before" verses an "After" treatment tests. The same test should be performed after the treatment at the same pumping rate, time for pumping, and the SC compared to determine success of rehabilitation.

Casing storage can vary with diameter of casing verses pump column pipe and an aquifer with a low Transmissivity . If you have any questions regarding casing storage call Design Water Technologies.

Design Water Technologies does sludge or debris analysis. Municipal: Check in top loaded water meters or check vales. Domestic systems: Drain the pressure tank and check inside the pipes at the "union joint". If a sample of any debris can be obtained from the pump or discharge piping close to the well, place it in a sealed container and send it to DWT, 5920 Covington Rd., Shorewood, MN 55331. Include a short explanation of the problem with your name, phone number, and fax number for a return report. This can be useful in determining the type of problem and to make sure there is nothing unusual about the debris. Recommendations can be made for treatment following this analysis.

Optional: TV Video of well and casing

Clean water shall be injected into the well for a period of 24 hours to help clear the turbidity prior to the video. A video shall be conducted of the entire casing and screen. Record any corrosive conditions of the casing or screen, unusual plugging observed on the screen, any unusual debris or objects in the well, and depth.

The following are 2 options for treatment of mineral scale or bacterial problems. Proceed to the "Development" section after either option. A third problem with physical plugging, i.e., silts or bentonite is covered after the "Engineer's Specification" section.

Option 1: Mineral Scale Applications

Physical cleaning

Most plugging due to minerals will occur within the screen. There are a couple of options for physical cleaning. 1. Concussion cleaning consists of a concussion impact within the screen to fracture hardened scale. There are several methods commercially developed to perform this task. If the contractor has experience with explosives, this process can be done with dynamite caps to obtain similar results. 2. Wire brushing the screen. Use a very stiff, poly brush on PVC slotted pipe or PVC screens. Use a stiff metal brush on metal slotted pipe, louver, bridge slot, and continuous slot screens. Always contact the brush manufacture if using on a continuous slot screen for potential damage. The chemicals can now penetrate more effectively on scale and debris outside the screen and into the formation plus this allows a better view of the casing and screen during a video. If there is a tremendous amount of scale buildup in the casing, use a casing scrapper or hardened drive shoe the size of the ID of the casing. Airlift or remove all debris prior to chemical treatment.

Chemistry and Placement of Chemistry

Recommendations for the "Unicid" Granular in screened wells or consolidated open borehole (rock) wells is available in our brochure, "Cleaning Wells and Pipelines". If you want to calculate specific chemistry for either type of well, **Screened wells:** *Multiply the total gallons of water in the screen, times 8.33 (pounds per gallon of water). Multiply the total pounds of water times 12-15% (0.12-0.05) to obtain the total amount of*

"Unicid" Granular acid to be used for the initial treatment. **Rock wells or consolidated formation wells with no screen:** *Multiply the total gallons in the open borehole (allowing for crevasses, etc.,) times 8.33 lbs/gallon times 5% (0.05) concentration. A lower concentration is generally recommended in this situation because the fracture joints are often a smaller percentage of the formation and the formation is generally a much lower calcareous content.*

In either case, have a surface tank at the well for mixing the Granular. Multiply the total pounds of Granular times 0.6 for the gallons of water for mixing as not to exceed the saturation point. Have that amount of water in the tank. Start a circulation with any standard pump within the tank and slowly pour the Granular into the intake of the pump and recirculate to mix until all Granular is totally dissolved. If the screen or open borehole is less than 50' in thickness, place a tremie line to just above the screen or open borehole and pump the entire initial dosage of chemistry into the well. If the screen or borehole is greater than 50' thick, pump the chemistry through the tremie line in equal increments throughout the formation. Do not exceed 50' increments. Start development immediately. Proceed to "Development".

Option 2: Slime or Iron Bacteria Applications

Physical cleaning

Bacterial problems may occur in the entire column of water in a well from the static level to the pumping level, at the intake of the pump, or high velocity areas of a screen or open borehole. All areas may include high areas of oxygen or velocity.

The well shall be physically cleaned with a stiff wire brush to remove as much mineral scale and bacterial debris as possible prior to treatment. Use the "WireHog" poly brush on PVC, non-metal casing/screens or continuous wrap metal screens. Use the spring steel, "WireHog" metal brush on metal casing, slotted pipe, louver screens, or continuous wrap screens. Wire brush the casing from the static level to the very bottom of the well 3-5 times. Airlift all debris from the bottom of the well. If airlifting is impractical, bail or pump debris from the bottom of the well prior to chemical treatment. The chemicals can work more effectively on bacterial debris outside the screen and into the formation plus allows a better view of the casing and screen during a video. Physical concussion methods of treatment (Sonar, Air Burst, etc.) are another method of cleaning as long as all debris is removed from the well prior to chemical treatment.

Beware! *If H2S gas (rotten egg odor) is noted in a well prior to treatment, wire brushing may remove physical debris in the well. This may release massive amounts of gas created by anaerobic, Sulfate Reducing Bacteria. The use of breathing apparatus may be required even in an open air environment.*

Chemistry and Placement of Chemistry

The entire column shall be chemically treated with a combination of the "Unicid" Granular acid and "Unicid" Catalyst. Refer to the manufacture's brochure, "Cleaning Wells and Pipelines" for dosages of chemistry per foot of water in the well or call the manufacture's technical service for dosages on a specific well.

If the static is less than 100' and the column of water in the well is less than 200' thick,
Pour the total amount of the initial dosage of Granular into the well from the surface, followed by the liquid Catalyst. Flush the casing above the static water level with plain water to remove excess chemicals. Start development immediately.

If the static is greater than 100' or the column of water in the well is greater than 200' thick,
Calculate the dosages for the "Unicid" Granular and Catalyst for total amounts of chemistry from the dosage charts. Set up a surface tank near the well. Multiply the total pounds of "Unicid" Granular x .6 for total volume of water for mixing. The maximum saturation point for the Granular is 2 lbs per gallon. Start a recirculation within the tank and slowly pour the total amount of Granular into the intake of the pump for mixing. Once mixed, slowly add the total amount of Catalyst and circulate to mix. Divide the total footage of water in the well into equal increments not exceeding 50' increments. Set a tremie line and displace the mixed chemistry equally in the well to the static level. Start development immediately.

Development

Note: There are several types of development and many variations of each type. Our intended use of development strives to obtain 4 objectives,

1. *keep the chemistry within the borehole to keep it concentrated. This allows the monitoring of pH and color to use as a comparison during treatment. You may see a huge change in pH in a short period when all debris is dissolved and dilution becomes a factor when chemistry mixes with the groundwater.*
2. *effectively move chemistry through the screen openings or into the borehole in two directions.*
3. *since scale and bacterial debris have a tendency to build greater amounts in the most prolific areas of the screen or borehole, any development must force "localized" activity in each area of the screen or borehole to push chemistry into that area.*
4. *once the debris is totally dissolved, remove any physical debris (clays, fine silts, original drilling fluids) to enhance well efficiency and reduce pumping costs.*

An explanation of the basic types of development is in our brochure, "Cleaning Wells & Pipelines". We only recommend to use of simple air development and "Rawhiding" with screens or open boreholes that are less than 10' of length. In open boreholes and screens longer than 10', we prefer a more localized development method using a surge block, airlifting between a packer system, or jetting and retrieval of chemistry between a packer system.

Start the development process immediately once chemistry is in the well.

Surge Block: Start any surging (surge block) action from the bottom of the well and work upward in even sections and time increments to the static water level. Once the development tool reaches the top of the screen or borehole, check for fill in the bottom of the well and if greater than 20% of the well screen or open hole, bail the debris out. Monitor any debris recovered for content, i.e., color of scale/sludge, percentage of scale/sludge of total debris, sand, etc. The percentage of sand may become present or may increase as plugging debris is dissolved. Surge for 3-4 hours and check the chemistry for color and pH with a bailer.

Airlift Development: Use only in screens or open boreholes that are less than 10'. Set an airline or eductor pipe with an airline inside the screen/borehole, near the bottom of the well. Use a quick release gate valve on the well side of the airline to allow the release of air from the airline once the air is shut off. This prevents continued air in the line to push chemistry over the casing at the surface. When the air is turned on, chemistry will rise in the well. When that level gets to approximately 7-10', shut off the air, open the quick release valve on the airline and allow the chemistry to fall. Repeat the process for 3-4 hours and monitor chemistry for pH and color.

Monitoring Chemistry during Development for Mineral or Bacterial Applications

Obtain samples of the chemistry from the well (with a bailer) every 3-4 hours during development and monitor pH and color. Use any standard bailer. Make sure you have a good seal on the bottom of the bailer to keep the sample accurate from that point of the well. Take the sample within the well screen. In longer lengths of screen multiple samples can be taken. When using an airline for development, you may get good enough to capture a sample in a cup from the surface without overflowing chemistry. pH will start below 1.5.

Colors

Yellow*/iron* **Black***/manganese* **Brown/tan/white***/calcium*

If other colors exist other than green (sell below), call the Technical Service Toll Free number for information. When pH rises above 3.0, adjust pH downward by adding an additional 30% of the initial dosage of <u>just</u> *the "Unicid" Granular product in either mineral precipitate or bacterial problems if or w. Install the*

adjustment chemistry as the initial dosage. Continue development, monitor every 4-6 hours, and adjust as necessary. Always check chemistry prior to leaving site in the evening. Adjust chemistry if pH is greater than 2.5. Surge for 30 minutes to mix. In the AM, always surge for 30-45 minutes before checking chemistry to assure similar well conditions. If pH is greater than 3.0 adjust accordingly. If pH is lower than 3.0, surge and develop for 2-4 hours and recheck pH. Keep a log of time, pH, color, and pH adjustments for final review. You may see a lengthening of adjustment frequencies. Once pH stabilizes under 3.0 for several hours (4-12 depending upon adjustment history) and the chemistry color is yellow, brown, tan, or black, the cleaning process is complete.

If pH does not rise in 3-5 hours and the coloration (above) in the sample is somewhat clear, the chemistry may not have anything to work on in the well and the assessment of the problem may have to be reviewed.

Green*/sulfate*
Sulfate is generally different as there is limited carbonates available. Therefore pH is not affected when dissolving sulfates. Check water chemistry and you will generally find sulfate greater than 50 ppm. This scale is often very dense and the time of sampling may be longer as it takes more time to dissolve. If the chemistry begins *as green, continue to develop and monitor pH. If the green color continues for over 10-12 hours, start to use a measurement of total dissolved solids (TDS) and monitor through two days of development. Once TDS and pH remain stable, the process of cleaning may be complete. You may see initial colors (yellow, black, or tan) and then change to green or the opposite may happen. That indicates a change from one type of debris to another or a layering of debris. Continue to develop for at least 4-6 hours. Coloration may change in a well several times.*

Toward the end of a cleaning process, you may find fine sand, silts, or clay particles in the recovered samples. This indicates a physical connection to the formation and the cleaning process may be complete. Continued development may be in order to remove this physical debris. You may use Mud Buster to further remove clay.

A variety of debris will react differently to chemistry. Most bacteria process iron (yellow) or manganese (black)but will often have a high percentage of oxygen in the organic debris. You may observe lots of bubbling in the well during treatment which is the release of that oxygen. A precipitate of manganese (black) scale will be more difficult and slightly slower to dissolve and the monitoring process may be 4-5 hours. Sulfates will require a longer timeframe to dissolve debris because of a lack of carbonate and pH will not be affected. You may see the coloration change several times during the cleaning process. See our "Monitoring of chemicals" in our brochure, "Cleaning wells and Pipelines" for further information.

Disposal

Once the rehabilitation is complete, the chemistry solution should be airlifted from the very bottom of the well. Again pumping (with a pump) from the very bottom of the well would be an alternate. It is important to remove all chemistry and debris from the bottom of the well *prior to pump installation. Pump out of the well into a large surface storage tank. Estimate the gallons in the tank and measure average pH with a pH meter or pH paper to determine the dosage for acid neutralization. "pH Neutralize" (liquid) shall be used to adjust pH of the acid to a minimum of 6 or a maximum of 9, for disposal. The required amount of product is based upon pH of the solution in the tank and the size of the tank. "pH Neutralize" can be injected on a constant feed basis using a gallon to gallon ratio based upon the usage graph on the container. This process is a little difficult to control because of fluctuating pH levels in the discharge. We recommend to containerize the solution for a final check of pH prior to actual disposal. Once neutralized, the chemistry can be disposed to a sanitary sewer, storm sewer, or land disposed with no environmental concerns. See MSDS and Product Specification sheets on each product for more information.*

Store the containers of "pH Neutralize" on site, up side down. Prior to use, shake the container vigorously, pour the required "pH Neutralize" into the acid solution at the surface, and mix. pH will be affected within minutes. Measure pH, and if within local regulations, dispose of the neutralized liquid. A second batch of acid solution should be pumped from the well and the process repeated. pH of subsequent batches could be expected

to be higher but will fluctuate. This process should be repeated until the natural pH of the water coming from the well is greater than 6.0 prior to disposal directly to a land disposal, sanitary sewer, or storm sewer.

Check with your local, state, or federal regulatory offices for requirements regarding disposal of acidic liquids and pH window for disposal. You will normally find the acceptable pH levels for disposal of acidic liquids between 6 and 9. There are no hazardous chemicals in any of the products. The "Unicid" Granular product is totally biodegradable in 9 days. The "Unicid" Granular and the Catalyst combination is totally biodegradable within 27 days. The "pH Neutralize" is a mineral that is entirely usable by plants and animals. The total chemistry can be pumped to a sanitary sewer, storm sewer, or land disposed without environmental concerns.

Do not treat or adjust pH in the well! The usage of any neutralization products may drive debris back into the formation creating additional plugging. Estimate 6 to as much as 15 times the total volume of water in the well for the total gallons of acid to neutralize at an average pH of 4 for an estimated dosage of "pH Neutralize". Follow usage guide for dosage requirements. Actual requirements will vary dependent upon the acid used, pH adjustments, calcareous content of the actual formation, and Transmissivity of the aquifer.

The "pH Neutralize" is a liquid product and can be set up as a continuous feed system into the discharge line or a tank and successfully neutralize the acid prior to disposal. Estimate average pH of the solution coming from the well. See our dosage charts on the container or our brochure, "Cleaning Wells & Pipelines". You will have to adjust injection rates as natural pH rises. Continuous monitoring of pH will be required but with the buffer system built into the product, pH will not rise above 9.0.

Options for disposal

1. *The "Unicid" chemistry can simply be land disposed without being neutralized as all products are totally biodegradable, and contains no hazardous materials but any solution with a pH lower than 5.0 will kill plants and potentially trees. Do not allow any discharge directly to a river or stream in this condition.*
2. *Soda ash or lime can be used with the "Unicid" chemistry but, a. pH will be difficult to control under 9.0, b. any remaining sludge from powders (20-30%) unmixed in the tank is classified as a hazardous material and will have to be disposed of accordingly.*
3. *We don't recommend the use of Caustic Soda because of usage dangers.*

See Engineer's Specification sheet and bentonite/silt removal on the following pages.

Engineer's Specifications for "Unicid" Chemicals

Mobilization and Demobilization of all necessary equipment *Lump Sum $_____.*

Initial Pumping Test. Includes all necessary equipment.
Estimate 1 hr @ $_____/hr. Total $_____.

Pull pump *Lump Sum $_____.*

Video casing and screen (if applicable) *Lump Sum $_____.*

Option 1 for Mineral Scale Application only
Wire brush the screen, includes airlifting/bailing/pumping debris,
Provide/install initial dosage of just "Unicid" granular
acid mixed at surface and placed through tremie
line throughout the screen evenly. _____lbs/ft of screen = _____lbs. Total $_____.

Adjustment of pH, (30% of initial
dosage of "Unicid" Granular)
includes mixing and placement. Initial dosage _____lbs x .30 = _____ Total/adj $_____.

Option 2 for Slime Bacteria/iron bacteria Application only
Wire brush the casing and or screen,
includes airlifting/bailing/pumping debris
_____hrs @ $_____/hr. Total $_____.

Provide and install initial dosage of "Unicid" Granular
and "Unicid" Catalyst.
"Unicid" Granular _____lbs/ft of water = _____lbs. Total $_____.
"Unicid" Catalyst _____gal/ft of water = _____gal. Total $_____.

Adjustment of pH, (30% of initial
dosage of just the Granular),
includes installation. Initial dosage _____lbs x .30 = _____lb s/adj. Total/adj $_____

Development, includes monitoring pH Est. _____hrs @ $_____/hr. Total $_____.

Airlifting/bailing of any debris & containerizing, if necessary *Lump Sum $_____.*

Neutralization/Disposal, includes chemistry,
all necessary tanks, equipment, labor, removal from site, etc.
"pH Neutralize" Est. _____/gal @ $_____/gal. Total $_____.

2nd comparative pumping test. Includes all necessary equipment
and reinstallation of pump. Est. _____hrs @ $_____/hr. Total $_____.

Well disinfection and hook up into system *Lump Sum $_____.*

DESIGN WATER TECHNOLOGIES

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Option 3: Physical Debris: sand, silts, clay, or bentonite removal

The third potential for plugging in a new well or old is physical debris. There are so many options to consider that we don't believe there is one specification that can be written to cover all circumstances. We will attempt to give you some guidelines. If you require further assistance, please e-mail or call our toll free technical service line.

Unconsolidated aquifers: This is categorized as aquifers that can not stand open during pumping and would require a screening device. In present wells, any reduction of SC can be due to an infiltration of silts, fine sand or clay particles into the borehole or sand/debris filling the screen causing a blockage of water. Formation filling into a screen may indicate poor well design, i.e., poor slot or filter pack selection or physical problems in the formation or filter pack. In some cases seismic activity can loosen semi consolidated formations creating sand pumping or fill in a well. If a well has been pumping some sand over time, vacating sands may create a void areas causing a sluffage of material downward reducing yield potential. Development may not help in highly mobile formations.

Always measure the depth of the well and compare to the original depth. If screens are filled in with sand or debris, it must be bailed out prior to any redevelopment. Be aware, physical debris may be the only cause of plugging and chemical treatment may not be required. Review the drillers log, and any geophysical logging information available. This may help determine the potential for blocking certain production zones.

In new wells, expected yield may be lower than anticipated (low well efficiency) because of drilling damage and the lack of development.

Development in a new well that was drilled using bentonite

All bentonite products has a polymer chain (polyaccrilimide) added to increase carrying potential and "jell strength". The polymer is NOT biodegradable and is very difficult to break down without an oxidation process. Polyphosphates DO NOT break down bentonite plus can encourage bacterial growths. *There are several new non phosphate, polymer products on the market (Mud Buster included) that are very effective on silts and clays, BUT DO NOT BREAK this polyaccrilimide chain in Bentonite.*

1500 ppm chlorine will provide the oxidation power to break this chain. Use either 12-15% industrial grade, sodium hypochlorite or common household bleach (5.25-6% concentration) for this process. If using household bleach, DO NOT buy the "thickened" bleach. It uses silica beads as a thickening agent and may plug the formation further. See below for concentrations. We do not recommend the use of calcium hypochlorite (granular/pelleted) because of the potential for precipitation of calcium resulting in even further plugging.

This process also works well if you are having positive coliform in new wells drilled with bentonite.

Our recommended process is:

- *Step 1* Calculate the volume of the screen in total gallons. Include pipe sections of between screens.
- *Step 2* Multiply that volume by 2 to 3 times. E-mail or call our technical service if the annulus is greater than 6" for calculations of the borehole annulus and filter pack.
- *Step 3* Have a surface tank near the well with that volume of water (or multiple mixes to equal total)
- *Step 4* For 12-15% liquid chlorine: Multiply the total gallons by .012 gallons of chlorine. For 5.25-6% bleach: Multiply the total gallons by .03 gallons of chlorine.
- *Step 5* Fill the surface tank with the amount of water calculated in Step 3 and start a recirculation of plain water in the tank.
- *Step 6* Slowly pour the amount of chlorine calculated in Step 4 into the intake of the pump to mix.
- *Step 7* If screen length is less than 50': Set a tremie pipe to just above the screen and pump in the entire amount of water.
  If screen length is greater than 50': Set a tremie line and displace water in equal increments, say 30' or 50' sections.

Step 8 *Surge the well, preferably with a flexible surge block operating in the screen. Spend at least 15 minutes per 10' section. Pull surge block out of the screen but leave in the well.*

Step 9 *Let set overnight, minimum.*

Step 10 *Reset surge block to the bottom of the screen. Set an airline (or an eductor pipe and an airline inside the eductor pipe depending on well casing diameter and air lift ability) just above the surge block action area. A pump can be substituted for this same action. This provides a flow or gradient to the well, pulling in debris. The localized movement of the surge block enhances movement in the most plugged areas.*

Step 11 *Start the surge block action from the bottom of the screen and airlift/pump simultaneously. This creates high velocity conditions specific to a given area of the screen and a flow or gradient to the well at the same time. Debris will be pumped from the well by the airline/pump. Spend approximately 15-30 minutes per 10' section but if debris is still evident, continue process. Work your way upwards until you reach the top of screen.*

Step 12 *Lower the airline or pump to the very bottom of the well, pump to ensure all debris is removed from the well. Remove all piping and surge block from the well.*

Step 12 *Reset the pump and test pump for results.*

Mud Buster is used as a followup process after breaking the bentonite, if there are clays or silts present in the aquifer during drilling, or if there are silts or fine sand present in an older well.

Usage of "Mud Buster" ™ in unconsolidated formations to remove clays/silts in new or old wells.

Calculate the amount of water in the screen section only. Multiply the total gallons in the screen times 3 for sufficient dosage into the formation. If there are blank zones in-between screen sections, add just the amount of water in the casing only. Have a surface tank at the well with this amount of water.

The dosage for "Mud Buster" ™ is 1 gallon per 500 gallons of water. Divide the total gallons in the tank by 500 for the number of gallons of "Mud Buster" required for treatment. Example: 12" screen that is 40' long = 5.9 gal per foot x 40' = 236 gallons x 3 volumes = 708 gallons of water required. For Mud Buster, divide 708 by 500 = 1.4 gal of Mud Buster will be required. For smaller tanks, use multiple batches.

Start a contractor pump recirculating water in the tank. Pour the liquid "Mud Buster" into the intake of the recirculation pump to mix. Set a tremie line into the well to pump chemistry into the well screen at maximum strength.

<u>For screens shorter than 50</u>*' in length: Set the tremie line just above the screen and pump in the entire amount of chemistry.* <u>For screens & combinations of screen/blank casing longer than 50</u>*': Divide the total length of screen and blank casing between screens into equal 30' to 50' increments. Example: 120' screen with 40' of blank casing in-between screen sections = 160'. 160' divided by 40' = 4 placement points for chemistry. Divide the total gallons by 4 for the amount of chemistry to pump at each placement point. Start at the bottom of the well and work upwards until just above the top of the screen increment.*

Start development immediately. Localized development is critical and a surge block operating throughout the entire screen area will allow more specific movement in the screen. Spend at least 15 minutes per stroke cycle. For example, a cable tool rig has 3-4' stroke, then move upwards in the screen. If using a pump truck or sand line, use increments of either 10' or 20'. Try to keep the vertical velocity greater than 2-3' per second to create better horizontal movement through the screen openings. When you reach to top of the screen, let chemistry set for a minimum of 12 hours.

Reset the surge block to the bottom of the well. Set an airline, airline inside an eductor pipe, or pump into the well just above the surge block vertical action area. Start the surge block at the bottom of the screen while pumping the well to create a gradient to remove debris. Continue the development/pumping in this area until the discharge clears. Work upwards in the well in the same increments as the original development. Continue downwards in the opposite development and pumping process until you reach the bottom of the well. Pump all debris from the very bottom of the well. Reset the pump, test pump for results and compare to original test.