Preparation and Planning for Well Rehabilitation

Introduction

Benjamin Franklin is credited with the now-famous quotation about certainty when he observed the following: *"Certainty? In this world nothing is certain but death and taxes".*

Most would agree that his observation remains on point today; however, had old Ben been discussing water wells, he might well have said: "*Certainty? For water wells, nothing is certain but rehabilitation followed by another episode of rehabilitation".*

The one certainty for water wells is that at some time within their useful lifetimes most of them will need some type of rehabilitation to improve their performance. The frequency of rehabilitation is something that is unique to each facility. Some wells have been known to operate well beyond 10 years before needing attention, while others require rehabilitation at intervals as short as 2 to 3 years. Many variables are known to contribute to reduced performance including well screen and casing corrosion, incrustation, wear due to sanding, and, in some cases, structural failure.

The key to effective and cost-controlled well maintenance is the process of identifying the cause(s) responsible for reduced performance. This can be a difficult task. However, if the well operator has properly maintained complete records and understands what data are needed to assess well performance, it can be a relatively straightforward exercise to evaluate and diagnose well problems. It all begins with gathering data that can be used to identify an effective course of remedial action.

This memorandum briefly describes the types of information that are most often needed to formulate a remedial action plan for well rehabilitation.

Useful Purpose

Well data can be used to perform various valuable assessment tasks. The forward-thinking operator collects, organizes and properly maintains historic performance data that can be used in myriad ways. For instance, the well operator can:

1. Identify the initial sign(s) of well problems before they escalate into more significant problems that require costly remedial action.
2. Distinguish between performance problems whose origins are related to the well, the pump, or the aquifer.
3. Facilitate decision-making as to the appropriate course of rehabilitation.
4. Reduce the cost of rehabilitation by identifying the "real cause(s)" of the problem, thereby eliminating guess-work and needless action.

Record Keeping

Well problems are usually identified from indicators such as loss of well production, low overall plant efficiency (OPE) related to the pump, sand production, or degraded water quality. Therefore, well operators should have a regular schedule for data collection. In addition, records on well construction should also be maintained. Well data and records include:

- **Static water levels** – regularly scheduled measurements of static water level should be made at least 2 times per year. Preferably, monthly measurements should be made so that a well defined hydrograph can be plotted. However, if only two measurements are made, they should be scheduled in the Fall and Spring, when water levels would typically be at their lowest and highest levels, respectively.

  Water level measurements should be made with an electric sounder or pressure transducer. Airline measurements are less accurate.

- **Specific capacity** – defined as the rate of discharge per unit of drawdown (expressed in gallons per minute per foot), this parameter is a valuable indicator of well performance. Specific capacity is calculated by dividing the rate of discharge from the well (in gpm) by the drawdown (in feet). By comparing historical specific capacity results at various times, one can check for trends indicative of various problems related to production decline such as clogging of well screens by sediment, biofouling, or incrustation. In some cases, declining specific capacity may simply reflect the lowering of local static water levels due to seasonal change or drought.

- **Overall plant efficiency** – this parameter is peculiar to electric-powered pumping plants. It is a measure of how much power (in kiloWatts) is converted to horsepower and is based on the ratio of water horsepower to input horsepower. Various data are needed to calculate OPE, as follows:

Static and pumping water levels (ft)	Electric meter multiplier (K)
Capacity (gpm)	Electrical meter revolutions (R)
Discharge pressure (psi)	Time of electrical meter revolution (T)
Electric meter factor (Kh)	

  OPE is calculated in four steps:

  Input Horsepower (IHP) = (K x R x Kh x 4.83 / T) (1)

  Where:

  K = electrical meter constant (shown on meter)
  R = electrical meter disc revolutions
  Kh = electrical meter factor (shown on meter)
  T = time of disc revolutions (in seconds)

  Head = PWL + (Discharge Pressure x 2.31) (2)

  Where:

  PWL = pumping water level

  Water Horsepower (WHP) = (Q x Head) / 3960 (3)

  OPE = (WHP/ IHP) x 100 (4)

- **Sand Testing** – the first indications of sanding are often observed in reservoirs where sand that is pumped from a well eventually drops out of suspension and settles. Checking for sand content at the well head is easily done with a Rossum sand tester. (Refer to Technical Memorandum 005-7). Sand production is usually the result of one or more conditions, such as:

- Structural failure - enlarged perforations or hole(s) in casing
- Deficient well design – improperly graded gravel envelope or slot size
- Ineffective well development

- **Water Quality** – these parameters may vary according to the well location. Parameters typically include total dissolved solids (TDS), temperature, electrical conductivity (EC), pH, and dissolved oxygen. Water quality results, evaluated at regular intervals (e.g. annually), can suggest a changed condition below ground; for example, the well casing may have corroded so that degraded water is able to enter the well; or, the changes may be due to a point-source problem.

- **As-Built Records** – the documentation for each existing well should include the as-built well design that was prepared by the well drilling contractor. As-built records typically include key construction parameters such as the type of casing material (e.g., mild steel, copper-bearing steel, stainless steel, or PVC), depth of well screen and blank casing, wall thickness, and slot size, As-built information can be used to assess the existing condition of a water well and evaluate baseline conditions. If as-built records are not in the well owner's files, they may be available from state and local agencies. Most states require well drilling contractors to file as-built well records as part of the well permitting process. In California, for example, each district office of the Department of Water Resources maintains a data base of as-built records which is accessible by well owners on request.

Other Investigations

Several other types of tests can be performed as follows:

- **Video survey** – this survey is commonly performed when the well head, pump, and column pipe have been removed. A camera with side-scanning capability is used to view and videotape the entire length of casing and screen for structural problems and clogging of the well screen in real-time and color.
- **Pump performance testing** – step-drawdown and constant-rate discharge testing.
- **Spinner testing** – spinner tests measure the contribution of ground water to the well from various depth intervals of well screen. Spinner testing is often conducted during initial pumping test of a new well as a baseline for future comparisons. At a later time, if a decline in production is observed, a follow-up spinner test can be used to determine the specific interval(s) of screen where changed conditions were found.
- **Bacteriological sampling** – biofouling within the well screen can be addressed most effectively when samples of biological growth are collected and identified in the laboratory. There are many types of biologic matter found in water wells that can lead to microbiological influenced corrosion (MIC). Left untreated, MIC can cause pitting, crevice corrosion, selective dealloying, stress corrosion cracking and under-deposit corrosion. (Refer to Technical Memorandum 004-9). However, if properly identified, biologic activity can be effectively treated by various chemical and/or mechanical methods.

Summary

Water operators who have a well organized data base of information on the performance, water quality, and downhole condition of every water well are better able to accurately assess changes in production, water quality, and structural integrity. The time, effort and cost of a scheduled well monitoring program can be counted upon to pay dividends when the time comes to diagnose the reason(s) for a change in well performance.

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