# Environmental Geo-Technologies, LLC ("EGT")
# Corrosion Monitoring Plan-2013

The material used for construction of each well component has been tested by manufacturers for compatibility with a variety of hazardous chemicals and conditions. Similar (although less resistive) well components are currently used at many other currently operating commercial deepwell ("UIC") facilities.

The EGT Corrosion Monitoring Plan ("CMP") is designed to ensure that well components are suitable for use in contact with the waste sources proposed for injection. The materials used in construction of the wells are intended to meet or exceed the standards set by the American Petroleum Institute ("API") and the American Society for Testing Materials ("ASTM").

The wellhead, injection tubing, interior surfaces of the packer, and casing shoe will be the well components in constant dynamic contact with the waste sources during periods of injection, and, the stainless steel packer, sealing elements, and Hastalloy casing shoe are all highly corrosion resistant. Another protective feature is that an inert liquid is emplaced beneath the packer in each well. Yet another protective feature is that the fiberglass injection tubing has an epoxy resin rich coating on its internal surface intended to maximize tubing service life. New wellhead assemblies were installed to address potential compatibility issues with contact of wetted surfaces with waste sources. These wetted surfaces are also coated to reduce the potential for impacts from corrosion. Specifications and additional details on individual well components are found in the completion reports included as attachments to the original permit application document.

The primary material of construction of each well's injection tubing is red box fiberglass which again, has an epoxy resin rich coating on the interior surfaces of the injection tubing. A test coupon is assembled from excess fiberglass tubing and that fiberglass coupon is installed in the surface effluent line between the final storage tank ("SST") and the wellheads. In this manner, the test coupon will be subjected to virtually identical conditions (injection temperature, flow rate, velocity, etc.) as the injection tubing. The test coupon will be removed on a regular monthly basis, and visually examined for signs of deterioration such as pitting or cracking. As necessary, weight change and/or dimension change of the sample will also be determined with accepted measurement techniques. Data will be reported to the U.S. EPA as required in EGT's two EPA UIC permits.

Since additional testing under dynamic conditions is not required by EGT's two EPA UIC permits for the remaining materials used in injection system construction which cannot be readily inspected at the surface, the Hastalloy and stainless steel or coated steel components will be tested as coupons and subjected to static immersion testing in synthetic waste sources prepared to replicate probable operating conditions. This testing will be conducted prior to the wells being returned to service to estimate expected service life. Additional testing of the materials of construction will be conducted in the future if deemed necessary based on operating performance of the surface equipment or the annulus monitoring systems. The procedure describing the testing of the coupon(s) follows later in this document. Should significant corrosion be detected in any observation or maintenance activities, additional non-invasive ultrasonic thickness testing may be conducted on selected wellhead and/or pipeline locations to monitor future conditions.

## Test Description (Coupons)

The following tests are recommended to initially characterize expected service life of the materials of construction. These tests are to be utilized, as appropriate, to assess material performance based on coupon samples. The tests are summarized here with a brief explanation of the reasons for and the objective(s) of each test.

### *Barcol Hardness*

This is a qualitative test used to investigate the deterioration of the fiberglass laminates. Fiberglass manufacturers have determined a Barcol hardness range for each fiberglass resin product. To determine damage, hardness must be measured before and after exposure. If hardness measurements fall outside the full cure range, then it is probable that the sample has been subjected to chemical attack after immersion in the waste sources bath. The chosen waste sources bath will be acidic hazardous waste since that is expected to be the most aggressive waste source. A significant increase in hardness value outside the manufacturer's specified range indicates a brittle condition of the resin due to waste sources exposure. A hardness reading decrease to a value outside the specification range would be indicative of fiber blooming (an attack on the resin) followed by a "wicking" or chemical attack permeating the laminates. Hardness will be measured initially for the fiberglass to establish a baseline prior to immersion. These test results will be qualitative in nature with hardness differences of 5.0 or less considered to be insignificant.

### *Mass and Thickness Determination*

This test is a quantitative test that can be used to indicate chemical attack on the fiberglass injection tubing. For other materials of construction, test coupons will be cleaned and weighed before and after exposure. Weight loss will be converted to an average penetration (corrosion) rate such as mils penetration or microns of penetration per year. These values will be compared to industry standards (such as ASTM and NACE) and to prior measurements to determine the expected remaining component life. Significant changes in mass will result in additional testing to determine the nature of the material degradation, if any. Should significant loss of mass be observed, calipers, and/or ultrasonic thickness measurements may also be used to assess changes in coupon thickness (prior to engaging in any destructive testing).

### *Visual Inspection and Microscope Determinations*

These qualitative observations are designed to visually identify any chemical attack on the surface of each coupon. If loss of mass has been noted in metal samples, the presence of cracking and/or pitting will be noted, and, average and maximum pit depth may be measured if corrosion has proceeded to the point that meaningful quantitative measurements can be determined.

### *General Procedures for Coupon(s) Utilization*

1. Prior to placing the coupons in the waste sources bath, each individual sample will be weighed on a laboratory digital electronic balance and fiberglass sample(s) will be tested for Barcol hardness. Visual observations and photographs will be made, and

photographic records from a stereoscopic microscope may also be included in the baseline records as appropriate.

2. The coupons will be removed from the sample holder, visually inspected, a Barcol hardness determination made (as appropriate for fiberglass), and the coupons dried and weighed prior to reinstallation. Anytime that significant change in mass, deterioration or degradation is observed, additional laboratory analyses may be required as herein.
3. A scanning electron microscope analysis may also be conducted on the initial coupon(s) and at least once per year to check for any "wicking" attack of the waste fluid into the fiberglass or effects on the fiberglass bonds.

The intent of monitoring as described in this document is to continuously estimate expected service life reduction due to corrosion of the well construction materials. Loss of mass, loss of thickness, cracking, pitting and/or other signs of corrosion will be reported to the EPA on at least an annual basis.

Note: ASTM Standards C-581 and D-2583 will serve as the procedures for the Barcol hardness determinations. If serious degradation of a fiberglass coupon is observed, further testing and analysis may be conducted (such as flexural properties determinations, ASTM D-790-5). The procedures referenced herein are subject to change as such ASTM procedures change.

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