STATE OF NEVADA
Department of Conservation & Natural Resources
DIVISION OF ENVIRONMENTAL PROTECTION
Jim Gibbons, Governor
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NEVADA DIVISION OF ENVIRONMENTAL PROTECTION
protecting the future for generations

February 24, 2010

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Re. **BMI Plant Sites and Common Areas Projects, Henderson, Nevada**
Soil Physical and Chemical Property Measurement and Calculation Guidance

Dear Sirs and Madam:

All of the parties listed above shall be referred to as "the Companies" for the purposes of this letter. Attachment A provides guidance regarding measurement and calculations for soil physical and chemical properties.

Please contact me with any questions (tel: 702-486-2850 x247; e-mail: brakvica@ndep.nv.gov).

Sincerely,

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Attachment A

Determination of the physical and chemical properties of the vadose zone soils are needed for site-specific evaluations of soil leaching and vapor intrusion. Soil samples should be collected for the evaluation of the physical character of the subsurface during site characterization. Soil can be submitted to a laboratory for the measurement of dry bulk density, grain density, moisture content, and grain size. The recommended geotechnical laboratory methods are as follows:

- Dry Bulk Density ASTM D2937;
- Grain Density ASTM D854;
- Moisture Content ASTM D2216;
- Grain Size ASTM D422; and
- Grain Size, Silt and Clay Fraction, ASTM C117 (soil particles finer than No. 200 sieve).

Total porosity is a calculated value using the equation (Fetter, 2001):

$$n = 1 - \frac{\rho_b}{\rho_s}$$

where: n = total porosity;
ρ_b = dry bulk density (M/L^3); and
ρ_s = density of solids (M/L^3).

Soil moisture (gravimetric basis) content reported as a percent is converted to volumetric using the equation (Fetter, 2001):

$$\theta_w = \left(\frac{\rho_b}{\rho_w}\right)\theta_g$$

where: θ_w = volumetric water content (dimensionless);
ρ_b = dry bulk density (M/L^3);
ρ_w = density of water (M/L^3); and
θ_g = gravimetric water content (percentage).

Air-filled porosity is calculated using the equation:

$$\theta_a = n - \theta_w$$

where: θ_a = air filled porosity (dimensionless).

For use of the soil-water partition (SWP) equation to calculate leaching-based site-specific levels (LSSLs) and unsaturated zone leaching models the soil chemical parameters fraction organic carbon (F_{oc}) and soil pH may be used to calculate a site-specific distribution coefficient (K_d). The recommended laboratory methods are as follows:

- Fraction Organic Carbon Walkley-Black method (Nelson and Sommers, 1992); and
- Soil pH ASTM 4972.

The NDEP does not approve the use of methods or standards that are not currently and actively supported by the organization that originally developed them.

REFERENCES

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Fetter, C. W., 2001. Applied Hydrogeology. Prentice Hall, Upper Saddle River, N.J., 598 p.

Nelson, D. W., and L. E. Sommers. 1982. Total Carbon, Organic Carbon, and Organic Matter. In: A. L. Page et al. (editors), Methods of Soil Analysis: Part 2 Chemical and Microbiological Properties. ASA [American Society of Agronomy, Inc.] Monograph Number 9, p. 539 – 579.