TETRA TECH EM INC.

September 28, 2006

Greg Haet
Associate Director, Environmental Protection
Office of Environment, Health & Safety
University of California, Berkeley
317 University Hall #1150
Berkeley, CA 94720

Subject: Fertility Recommendations for Richmond Field Station Wetland Restoration

Dear Mr. Haet:

This letter summarizes the results of Tetra Tech EM Inc.'s (Tetra Tech) evaluation of soil fertility at the Richmond Field Station project site. Additionally, this letter presents Tetra Tech's recommendations to improve soil fertility based on the results of our evaluation.

Poor plant growth has been observed on several plots of the wetland restoration area. As a result, Tetra Tech performed an evaluation of the soil fertility to determine if the soil is responsible for the poor growth conditions. Tetra Tech collected soil samples from six vegetation plots (1, 2, 5, 6, 9, and 10) and took pictures of the vegetation and landscape at the Richmond Field Station mitigation project site. Plots 1, 2, 5, and 6 were revegetated as part of the restoration program. Vegetation growth on Plots 1 and 2 was characterized as poor or very poor. The Watershed Project plans to fill in areas of poor plant growth and coverage with additional plants and to begin revegetating an upland area adjacent to Plots 1 and 2. Plots 9 and 10 are naturally vegetated. The table below summarizes the analytical results of the soil samples collected from each plot.

Plot	Sample	NO_3-N (mg/kg)	NH_4-N (mg/kg)	Total Nitrogen (mg/kg)	PO_4-P (mg/kg)	K (mg/kg)	Ca (mg/kg)	Mg (mg/kg)	Organic Matter (%)	CEC (me/kg)	Clay (%)
1	RFS-001	5	17	22	36	227	3,041	1,186	3.2	268	33.2
	RFS-002	3	10	13	32	215	3,306	864	2.2	235	31.2
2	RFS-003	3	9	12	44	491	1,694	1,610	2.9	285	51.2
	RFS-004	3	6	9	15	127	2,954	1,044	1.4	249	28.1
5	RFS-005	3	11	14	55	545	2,398	1,619	3.3	301	48.2
6	RFS-006	4	10	14	46	408	2,616	1,158	2.4	254	39.2
9	RFS-007	3	10	13	35	439	1,329	950	5.9	190	15.6
10	RFS-008	4	8	12	16	342	1,631	590	4.3	150	11.2

Notes:

% Percent
Ca Calcium
CEC Cation exchange capacity
K Potassium
me/kg Milliequivalent per kilogram
Mg Magnesium
mg/kg Milligram per kilogram
NH_4-N Nitrogen as ammonium
NO_3-N Nitrogen as nitrate
PO_4-P Phosphorus as phosphate

The results presented in the table above do not show any obvious fertility imbalance that would explain the observations of poor plant growth. All plots exhibited similar concentrations of nitrogen and phosphorus. The nitrogen concentrations are deficient relative to standards commonly applied for agronomic crops (Otto and others 1983, Tyler and Lorenz 1991). Although those standards do no necessarily apply to restoration projects, it is likely plants in all plots would show a favorable growth response to added nitrogen. Potassium levels in Plots 1 and 2 are lower than potassium levels in other plots, although the variability in potassium levels of Plot 2 masks the trend. Agronomic plants do not typically show a growth response to added potassium when potassium levels are greater than 100 to 150 mg/kg in soil. As a result, Tetra Tech does not believe additional potassium would resolve the growth differences.

The other parameters in the table above relate to physical and chemical properties of the soil. The organic matter content, the CEC, and the clay content are different for the plots that have been revegetated (Plots 1, 2, 5, and 6) compared with the plots with natural vegetation (Plots 9 and 10). The natural plots have more organic matter, lower CEC, and lower clay content. Tetra Tech could not determine if the organic matter and clay content levels are an artifact of grading activities during the restoration project. However, the lower CEC is attributable to the lower clay content.

A higher clay content could have a negative effect on plant growth. During a review of the photographs of vegetation and landscape, Tetra Tech noted several large desiccation cracks at the project site. These cracks indicate the clays have a high shrink-swell capacity, which can reduce the ability of plant roots to extend into the soil and results in a limited root zone. In addition, the plants are not able to use all of the available soil moisture during the growing season because the clays hold the water more tightly. The cracks seemed to be larger and more pronounced in Plot 1 compared with Plot 5. However, other site factors could exacerbate this situation.

Although there is little difference in the fertility status of soil in the revegetated plots (1, 2, 5, and 6) relative to the natural vegetation plots (9 and 10), some physical properties of the soils could negatively affect plant growth. As a result, Tetra Tech recommends amending the soil with a nitrogen fertilizer at the rate of 100 pounds of nitrogen per acre. Amending the soil will help establish the desired plants and provide a vigorous growth to endure the harsh conditions they may encounter during the revegetation phase.

The nitrogen source in the fertilizer should be considered a slow-release material such as sulfur-coated urea, Isobutylidene diurea, or ureaform. The fertilizer material should be applied in two applications of 50 pounds of nitrogen per acre each. One application would occur at planting, and the second application would occur approximately 12 to 16 weeks later. The low total nitrogen application, the split application, and the use of slowly available nitrogen sources for the fertilizer material will all act to help (1) reestablish the nitrogen nutrient cycle on the site, (2) minimize the availability of nitrogen for undesirable plants that might colonize the site, and (3) prevent nitrogen from leaching to adjacent surface water bodies. The decision to incorporate the fertilizer will depend on the final selection of fertilizer.

To prepare soil for seeding or reseeding, Tetra Tech recommends against the use of tillage implements such as rototillers, disk harrows, or moldboard plows in clay soils (greater than 30 percent clay). These implements can cause compaction, smearing, and surface sealing, which can reduce plant growth. Instead, Tetra Tech recommends using a chisel plow to loosen and aerate the soil. The chisel plow allows deep tillage with limited soil disruption and leaves crop residue at the top of the soil. A chain harrow should then be used to level the surface (reduce clods) and prepare the seed bed. Of course, clay soils should not be tilled when wet because of the increased likelihood of compaction and smearing.

If you have any questions or need additional information, please call me at (415) 222-8205.

Sincerely,

Leslie Lundgren

Leslie Lundgren
Project Manager

References:

Otto, H.W., Branson, R., and Tyler, K. 1983. Guide for Fertilizing Vegetables. Publication 1761. Small Farm Center, University of California Cooperative Extension, Davis, California.

Tyler, K.B. and Lorenz, O.A. 1991. Fertilizer Guide for California Vegetable Crops. Vegetable Research and Information Center, University of California Cooperative Extension, Davis, California. (webpage: http://vric.ucdavis.edu/veginfo/topics/fertilizer/fertguide.html)

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