R E P O R T

BMP RETROFIT PILOT PROGRAM
BIOFILTER SOD PEER REVIEW

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EXECUTIVE SUMMARY

Caltrans constructed nine biofiltration installations in Districts 7 and 11 as part of the BMP Retrofit Pilot Program. This report presents a peer review of sod used for these sites. Specific topics of the peer review include: past decisions and circumstances related to plant selection, the process used to grow sod for the biofilter installations, options for remediation of biofiltration sites that have failed to meet performance goals for plant cover, recommendations for future biofilter installations, information on potential growers, delivery times, and price information for plant material to be used in future biofilter installations, and a review of the BMP Maintenance Indicators related to the sod for the biofiltration sites.

The current installations are all planted with saltgrass (*Distichlis spicata*). This species was selected because it could be grown as sod and it was believed that sod would provide the best means of achieving full cover in a compressed time schedule. We have identified two problems associated with this decision. First, saltgrass is a warm season grass that is dormant during the winter. Plantings installed in the fall do not become established until the following warm season (May to September). Irrigation is required for saltgrass plantings because soil moisture is not readily available in the bioswales and biostrips during the summer growing season. The second problem is the decision to plant only one species. A monoculture is typically more susceptible to pests, disease, and invasion by weeds, whereas a mix of different species is more resilient to disturbance.

Winter dormancy also affected the quality of plant material installed at the biofilter sites. The nursery contract was implemented in mid-August 1998 because of delays in approval of the State budget. Plantings were established at the nursery very late in the growing season and most of the sod flats had less than 40 percent cover when they were planted in December 1998 and February 1999. Once the plantings were installed, low temperatures and low precipitation substantially delayed the establishment of the saltgrass.

Plantings appear to have been installed according to the specifications. However, several changes to the specifications are proposed that would improve the establishment of sod plantings. First, we recommend that the specifications include appropriate fertilizer and soil amendments. Second, we recommend that the specification to leave one-inch spaces between sod tiles that are filled with sand be deleted. Sod tiles should be placed without leaving gaps and the ends of the tiles should be staggered to prevent the formation of channels along the swale or strip. The third recommended change is to use a roller on the sod to ensure that no air pockets form between the sod and the soil.

Despite initial problems with establishment of the saltgrass plantings, all of the sites had reached at least 85 percent cover by the end of July 1999 and many of the sites had approximately 90 percent cover. This represented a dramatic increase in total cover from mid-May 1999 when the average cover of most sites ranged from less than 20 percent to approximately 40 percent. This success was probably the result of irrigation, warm weather, remedial plantings, and the maturity of the plantings.

Remedial plantings have consisted of saltgrass plugs, seed, and transplants. This approach is appropriate for plantings during the growing season, but a modified approach is recommended if remedial plantings are required after October 1999. Plantings during the late fall and early winter season should include a mix of species. Plants that germinate and actively grow during the cooler months of winter and early spring should be overseeded on bare areas. Physical erosion controls will be necessary to protect seeds for at least 75 days after the first rainfall of the season. Erosion

controls might include the placement of a blanket, mulch, or other biodegradable cover over the seeded portion of the site.

Additional monitoring and maintenance is recommended for the biofilter plantings. Some of the biofilter sites have large overstory trees such as eucalyptus that produce large quantities of leaves, bark, and other debris. This material may shade the plantings, causing dieback, and may also degrade the filtration function of the site. A second potential maintenance problem is weeds. Some weeds may be compatible with the function of the biofilters but others are undesirable. Weed species in the biofilter plantings should be monitored to evaluate whether it is necessary to develop and implement a weed removal strategy.

We recommend that future biofilter installations be implemented using a mix of plant species. The saltgrass plantings have been successful at achieving the desired cover, but this success has required substantial levels of effort and cost. Other species combinations may perform the same function with lower short-term and long-term costs. We provide a list of species (Table 2-3) that should be considered for future biofilter plantings. All of these species are capable of performing the design functions of the bioswales and biostrips. Most of these species are cool season grasses or herbs that germinate and grow during the winter rainy season. Therefore, these species should require less irrigation and can be implemented with shorter lead times for growing. Most of the species we recommend can be grown from plugs or seed and some of them produce rhizomes like saltgrass that might be compatible with a sod planting. Temporary irrigation systems should be provided for all future biofilter installations to supplement natural deficiencies that may occur during plant establishment.

1.1 INTRODUCTION

This report presents the results of a peer review of the sod in biofilter devices for the BMP Retrofit Pilot Program, Los Angeles and San Diego Biofiltration Sites. Specifically, this report presents a review of nine biofiltration installations constructed by Caltrans in Districts 7 and 11. For this study, Caltrans identified the following topics for review:

- Past decisions and circumstances related to plant selection;
- The process used to grow sod for the biofilter installations;
- Options for remediation of biofiltration sites that have failed to meet performance goals for plant cover;
- Recommendations for future biofilter installations;
- Information on potential growers, delivery times, and price information for plant material to be used in future biofilter installations;
- Portions of the BMP Maintenance Indicators document that address the sod for the biofiltration sites.

To address these topics, URS Greiner Woodward Clyde (URSGWC) collected and evaluated documentation regarding plant selection, plant propagation, planting design, performance criteria, and maintenance procedures. Seven of the nine biofilter installations in Districts 7 and 11 were visited on July 12, 1999. The results of these reviews are described in the following sections.

1.2 REPORT ORGANIZATION

Section One provides an overview of the biofilter project. Section Two describes the factors likely to affect performance of the biofilter installations, the process used to implement the biofilter installations, and highlights potential problems. Conclusions and recommendations for future biofilter installations and remediation of current biofilter installations are outlined in Section Three. Section Four provides references and personal communications utilized for the study.

1.3 PROJECT BACKGROUND

The Best Management Practices (BMP) Pilot Retrofit Program was developed in Caltrans District 7 with the following objectives:

- Determine the feasibility of design, construction and maintenance of selected BMP's;
- Evaluate the performance of the selected BMP's in removing constituents of concern from highway stormwater runoff; and
- Evaluate the frequency and magnitude of operational problems associated with maintenance of the structures.

The BMP Retrofit Pilot Program included the design, construction and monitoring of 38 discrete BMP pilot projects. The BMP's included in the Retrofit Pilot Program included trapping catch

basins, catch basin inserts, extended detention basins, infiltration basins, infiltration trenches, media filters, oil/water separators, biofiltration swales, and biofiltration strips. Multichambered Treatment Train devices were also installed to replace infiltration basins that could not be sited due to space constraints and inadequate soil characteristics.

The six biofiltration sites in District 7 are listed below:

- Altadena (biostrip)-IT
- I-605/SR-91 Intersection (biostrip)
- I-605/SR-91 Intersection (bioswale)
- Cerritos MS (bioswale)
- I-5/I605 (bioswale)
- I-605/Del Amo (bioswale)

Three additional biofiltration sites are located in District 11:

- Melrose Ave/SR-78 (bioswale)
- I-5 Palomar Airport Road (bioswale)
- Carlsbad Maintenance Station (biostrip)

2.1 FACTORS AFFECTING PERFORMANCE

Biofiltration swales and strips (biofilters) are vegetated pathways that remove target constituents by filtration through vegetation, deposition in low velocity areas, and infiltration into the soil. Biofilters are typically designed to remove suspended solids and metals associated with particulates, such as lead and zinc. Constituent removal efficiency is related to facility dimensions, longitudinal slope, and type of vegetation. Increased removal of solubles, particularly nutrients and soluble metals, may be accomplished with reductions in flow rate, and increased contact time with swale vegetation.

Successful establishment and growth of the biofilter planting is a function of several factors. These include:

- Physical and chemical site characteristics;
- Selected plant species;
- Propagation and installation of the planting; and
- Maintenance of the planting after installation.

The following sections review and evaluate the process used to select plant species, propagate plants, install plantings, and maintain the plantings after installation for the BMP Retrofit Pilot Program biofilters.

2.2 PLANT SELECTION

Plant selection is a critical component in the success or failure of a biofilter installation. Important considerations include:

- Compatibility with the physical conditions of the installation site;
- Growth form of the vegetation; and
- Maintenance requirements.

Potential plant species were selected for the BMP Retrofit Pilot Program based on their ability to meet the following minimum standards:

- Filter suspended solids from runoff from paved areas;
- Withstand one-year storm events (flow);
- Compatible with climate conditions in Caltrans Districts 7 and 11;
- Tolerant of seasonally wet and dry conditions;
- Low-growing (to maintain structure under flow conditions); and
- Low maintenance requirements (mowing, watering, and fertilization).

A list of species that met these criteria was compiled (RBF 1999). A mixture of plant species was recommended that would have paired fast-growing annuals with slower-germinating perennials. This approach would ensure short and long-term cover and enhanced resistance to

diseases and pests. However, the initial plan to utilize a mix of grasses was abandoned in favor of a saltgrass monoculture that could be grown in sod flats.

Saltgrass (*Distichlis spicata*) is a halophytic (salt-tolerant) grass that occurs naturally in the upper zones of salt marshes and in the alkali sink scrub community of inland areas with saline soils. The wetland indicator status of this species designates it as a facultative wetland (FACW) species that is typically found in wetlands but occasionally occurs in uplands. Saltgrass typically occurs on sites with soil that is moist or wet during the late spring and early summer growing season.

Saltgrass plants endure high soil salinity by excreting salt with specialized glands. As a result they often have visible salt crystals on their leaves. In inland areas of the western United States saltgrass is found as the dominant or co-dominant species in both in temporarily flooded and intermittently flooded habitats.

Vegetation height, cover and species diversity tend to vary inversely with salinity. In areas where soil salinity does not afford it an advantage, saltgrass is prone to invasion and competition from weeds. This is the case for the biofilter sites in Districts 7 and 11. Control of invading species is expected to require more frequent maintenance than in a mixed-species cover. Presently, biofilter sites are weeded manually every three weeks.

2.2.1 Discussion

The decision to utilize a saltgrass monoculture sod was motivated by the need to achieve full plant cover in the shortest possible time. That criterion took precedence over other factors that affect the long-term biofilter maintenance and performance.

Despite the limitations of a monoculture planting, saltgrass has some characteristics that are beneficial in a biofilter installation. It is a perennial grass that grows from rhizomes and stolons and once it is established it forms a tough, mat-like cover that is tolerant of disturbance. Saltgrass grows 15-50 centimeters (6-20 inches) high. This species is also adaptable to harsh soil conditions and tolerates seasonal soil saturation and sediment deposition. However, saltgrass is a warm season grass that goes dormant during the coolest winter months and does not germinate during the winter.

This section highlights four issues that are relevant to the plant selection process: timing of plant selection, differences between biofilter swales and biofilter strips, the selection of a monoculture versus a mix of species, and the problems posed by winter dormancy.

Timing of Plant Selection. One of the keys to successful implementation of a BMP is flexibility in adapting the proposed BMP to the site conditions. For that reason, the Water Pollution Control Department of the Municipality of Metropolitan Seattle, who has conducted a Biofiltration Project, recommends that selection of the appropriate vegetative cover be done at the earliest stage possible. It should be done after estimating the runoff flow rate (Q) at the site for the 6-month frequency, 24-hour storm and establishing the slope of the proposed biofilter (Metro 1992).

Early selection of the vegetation is necessary to establish the height of the vegetation during winter and the design depth flow. According to Metro (1992) specifications, the design depth of flow should be at least 2 inches less than the winter vegetation height. The choice of vegetation, and the frequency of mowing necessary, also help determine the appropriate Manning's

roughness coefficient (i.e., "n value") to be used in the approximation of swale geometric shape and calculation of biofilter width.

Early plant selection is critical to provide enough lead-time for the supplier of the plant material. The Caltrans biofilter plantings illustrate the problems that arise when there is inadequate time to propagate and grow the plant material. The contract with the nursery for propagation of the saltgrass plantings was delayed because the State budget remained unsigned until mid-August 1999. Plantings were established at the nursery late in the growing season and failed to reach full cover before they were planted (Bohn 1999). Most of these plantings did not reach full cover until the end of July 1999 (Table 2-1).

Metro (1992) advised on the following provisions for the selection of vegetation cover:

- Vegetate uniformly with fine, close growing, water resistant grasses
- Preferably use vegetation species that are native to the region
- Consider the possibility and desirability of wildlife habitat development when selecting vegetation

In regard to the latter provision, an evaluation of the BMP Retrofit Pilot Program in terms of endangered, threatened and sensitive species was done after the planting of saltgrass in the biofilters had already taken place (Dudek 1999). That study recommended that saltgrass be specifically avoided for coastal BMP sites to eliminate the possibility of colonization by the salt marsh skipper (*Panoquina panoquinoides errans*). That butterfly uses saltgrass as larval food and occurs along the coast between Santa Barbara and the cape region of Baja California. The skipper is a U.S. Fish and Wildlife Service species of concern. The co-location of a BMP facility and a possible habitat for the butterfly may be undesirable due to the need to maintain the BMP, which could disrupt the habitat.

Consideration of Differences between Biofilter Swales and Biofilter Strips. The BMP Retrofit Pilot Program treats both swales and strips equally in regard to choice of vegetation cover. Grass swales are shallow, grass-lined, typically flat-bottomed channels that convey storm water at moderate slopes. Filter strips are not channels, but vegetated areas that accept highway runoff as overland shallow sheet flow. The mechanisms of removing constituents from the runoff for both swales and strips are the same: filtration by the vegetation, sedimentation, infiltration into the soil, and biological activity in the vegetation and soil media. However, the dynamics among those mechanisms vary from swales to strips.

Walsh and others (1997) conducted a literature review of the factors that affect removal efficiency of vegetated BMP's for treating urban runoff. Those factors include vegetation type, slope, flow velocity, flow depth, season of the year, and length of the biofilter. Not enough studies have been conducted to determine the relative importance of those various factors with regard to the performance of swales and strips. However, differences in function, hydrology, or maintenance requirements may favor different species for individual applications.

Selection of a Monoculture Versus a Mix of Species. Saltgrass was considered the only species with suitable characteristics to be grown as sod and to perform the bio-filtering function (Appendix H of the BMP Retrofit Pilot Program's Quarterly Status Report No. 5). This decision was predicated on the decision that a sod-like planting was necessary to achieve full plant cover

in a minimum amount of time. However, a mixture of plant species would achieve this same objective as noted in Appendix H of the Quarterly Status Report (RBF 1999).

The saltgrass sod installations failed to rapidly achieve the full cover desired because of the inadequate lead time available for propagation and the winter dormancy characteristic of this species (RBF 1999). The contract with the nursery was established in late August 1998 because the State budget remained unsigned until mid-August. The ensuing fall, winter, and spring was cooler than normal which delayed establishment of the saltgrass at the nursery. As a result, the plant cover at installation was extremely low: typically 10 percent for the sites installed in February (Table 2-1).

Recent improvements in saltgrass cover at the biofilter sites (as of late July) demonstrate that the plantings perform much better with warm weather and irrigation. However, the sod may not be the most effective solution for achieving full cover in the shortest amount of time.

A species mix may offer a some advantages over a monoculture. These advantages include greater resilience to diseases and pests, less need for weed control, and greater adaptability to different site characteristics.

Dormant Grasses. The saltgrass design review and assessment (Appendix H of the BMP Retrofit Pilot Program's Quarterly Status Report No. 5) acknowledges that saltgrass is a warm season grass, and as such, it goes dormant and turns brown during the coldest winter months. This seems a highly important point since winter is when most of the runoff will take place in the region of the BMP program, and when removal performance is most needed. Some uncertainty exists as to the removal performance of grass swales during periods when the grasses may become dormant. Walsh and others (1997) have indicated that pollutant removal continues even in dormant grasses through the filtration by rhizomes. Although saltgrass is dormant during the winter season, an established stand of saltgrass will have a large surface area that may still be capable of removing suspended solids by facilitating deposition and allowing infiltration into the soil. To assess this capability, it may be desirable to design an experimental approach to compare the pollutant removal performance of a cool season planting mix (e.g. Table 2-2) versus a warm season saltgrass monoculture.

2.3 PLANT PROPAGATION AND INSTALLATION

Several aspects of the plant propagation and installation are reviewed below, including the selection of sod versus seed, the process used to grow the sod, and installation of the plantings.

2.3.1 Seed Versus Sod

One clear advantage of sod is the convenience of having instant vegetative cover. The rationale behind the use of sod is to achieve rapid and uniform cover of the swales and strips. That was not achieved due to time constraints that required the plants to be grown during the final months of the growing season. Recommendations for improving the timeliness of the nursery contract were made in the Quarterly Status Report No. 5 (RBF 1999). The question remains whether the higher cost of sod is justified for the remainder of the BMP Retrofit Pilot Program. Alternative methods for planting saltgrass or other mixes of species may warrant additional experimentation. A discussion of options for planting and species selection is presented in Section Three.

2.3.2 Process used to grow the sod

The number of stolons present in the sod determines the degree of coverage achieved by the sod. Stolons are sections of grass stems, containing nodes that are capable of taking root and forming a new plant. The conditions of the soil where the sod is grown, the temperature, competition from weeds, and the amount of water and fertilizer used are important factors in determining the growth and development of sod.

Saltgrass is a warm season grass. As noted earlier, the contract grower was not provided with enough lead time to propagate the sod before the end of the growing season. At the time of delivery, the saltgrass sod flats exhibited varying degrees of germination, ranging from 40 percent to no germination at all. While no record was kept of which flats were destined to what sites, it appears that flats with various degrees of cover were not combined prior to distribution to the sites. The sites in District 7 seem to have received the flats with lower estimated cover values (Table 2-1).

2.3.3 Planting Installation

The sod planting and maintenance specifications were reviewed. Based on our observations and conversations with the contractor, it is our understanding that the plantings were installed correctly according to these specifications. However, we feel that the specifications can be improved to promote the successful establishment of future plantings.

The condition of the soil at the receiving site is an important variable that needs to be addressed prior to installation of biofilter plantings. Placement of healthy sod on nutrient-poor, packed, rough soil typical of engineered slopes creates a “perched” water interface. Irrigation water is prevented from draining down through the soil. At the same time, the water interface does not allow upward movement of water and nutrients to whatever root structure is left on the sod. Moreover, continued trapping of water in that interface may prevent the sod from establishing deeper roots and create conditions for fungus growth.

The specifications for soil preparation provided to the saltgrass sod contractor included roughening the soil to a depth of two to four inches and raking the soil surface smooth. However, the specifications did not include soil testing and addition of appropriate amendments prior to sod installation. Typical specifications for preparation of turf areas require that the soil receive the following fertilizer and soil amendments per 93 square meters (1,000 square feet) and thoroughly rototilled into the top 15 centimeters (6 inches) of soil: 73 kilograms (160 pounds) of agricultural gypsum, 8 kilograms (18 pounds) of fertilizer and 4 cubic meters (5 cubic yards) of soil amendment (San Jose DPW 1992). A schematic of a typical biofilter swale shown in the scoping study recommends tilling 5 centimeters (2 inches) of compost into the top 15 centimeters (6 inches) of native soil, however this was not included in the specifications.

After the addition of amendments the soil needs to be raked smooth and be moist at the time of sod installation. The planting and maintenance specification requires watering the planting area to a depth of 3 inches. Adequate conditions in the receiving soil and establishing good contact between sod and soil is crucial to avoid the creation of perched water. The specification given to sod installers for leaving one-inch spaces between tiles and filling them with sand, may exacerbate the creation of the water interface. It can also promote the creation of channels along the swale or strip. It is advisable that sod be placed without leaving gaps and that the ends of the

sod tiles be staggered. Further, a roller should be used to ensure that no air pockets form between the sod and the soil.

2.4 MAINTENANCE

Appendix G of the Quarterly Status Report No. 5 presents the latest revision of the BMP Maintenance Indicators (RBF 1999). Nine design criteria or routine actions are proposed for the preventive maintenance and routine inspection of biofilter swales and strips. We recommend that three of those indicators be strengthened to improve the biofilter performance:

- Vegetative cover;
- Debris accumulation; and
- General maintenance.

Each of these maintenance indicators is discussed below and recommended changes are outlined.

2.4.1 Vegetative Cover

The BMP Maintenance Indicators document proposes to assess vegetative cover as follows:

- **Action**: Assess adequate vegetative cover.
- **Indicator**: Less than 90 percent coverage in strip.
- **Field measurement**: Visual inspection of strip/swale.
- **Frequency**: Assess quantity needed in May each year.
- **Maintenance activity**: Order appropriate amount of sod. Resod barren spots.

Discussion. There are two issues associated with this maintenance indicator. One issue is the timing and type of information recorded during the inspection. The second issue is the timing of remedial planting. A better definition of this indicator will help achieve more successful plantings and permit interpretation and identification of key biofilter parameters.

Additional strategies for remedial plantings should be developed. Saltgrass is a warm season grass that does not germinate and does not grow substantially during the winter. This characteristic should be addressed in the timing of planting and the timing of the monitoring.

Recommendation. Biofilter vegetation should be monitored at the beginning and the end of the growing season to compare growth and development. Orders for saltgrass should be placed with the nursery no later than June 1 of each year. Allowing for a typical delivery schedule of 3-4 months, this would permit planting by the end of the growing season in September. However, plantings at this late date will have less time to become established before they enter dormancy. Dormant plantings may experience higher mortality due to scouring and dislocation of plantings during high flow events.

Section 3.3 describes remedial planting strategies that could be implemented. Appropriate strategies could include overseeding the bare areas with a plant mix that will grow during the cool season (Table 2-2). If desired, saltgrass sod, stolons, or plugs could be planted the following spring as soil temperatures approach 18 °C (65 °F). This would ensure that planting

occurs after the rainy season, thereby minimizing the risk that peak flows would dislocate the plantings. These plantings would require irrigation during the first growing season.

The visual inspections at the end of the growing season should evaluate:

- Distribution of barren spots and browning;
- Location of covered and not covered areas in regard to strip/swale topography;

A schematic drawing of the bioswale or biostrip should be used to note the location of bare spots and browning. This information would provide a baseline from which to compare future monitoring data. Areas within that have persistently low cover may require remedial measures to address problems with the slope, soil, water flow, or irrigation.

2.4.2 Debris Accumulation

The BMP Maintenance Indicators document proposes to inspect for debris accumulations as follows:

- **Action**: Inspect for debris accumulation.
- **Indicator**: Debris or trash present.
- **Field measurement**: Visual observation.
- **Frequency**: Monthly.

Discussion. The proposed maintenance indicator should be expanded to include vegetative debris. Leaf litter from large trees at the Melrose Avenue/SR 78 Site, I-605/Del Amo Site, Carlsbad MS Site, and others may accumulate on top of the plantings, shading them and causing mortality or dieback. Debris accumulation may also reduce the filtering capacity of the biofilter. This activity could be conducted as part of the debris accumulation inspection or as part of the special status species inspection.

Recommendation. Remove vegetative debris, including leaf litter, branches, or bark.

2.4.3 General Maintenance

The BMP Maintenance Indicators document proposes to conduct a general maintenance inspection as follows:

- **Action**: General maintenance inspection.
- **Indicator**: Inlet structures, outlet structures, side slopes or other features damaged, significant erosion, emergence of trees or woody vegetation, fence damage, etc.
- **Field measurement**: Visual observation.
- **Frequency**: Monthly.

Discussion. The proposed maintenance indicator does not cover weed removal. The saltgrass plantings may be susceptible to competition from invasive weeds. Many of the biofilter installations have well-established populations of invasive weeds growing in close proximity. These populations will provide an ample source for continuous recruitment and establishment of undesirable plant species in the biofilters.

Not all weeds are incompatible with the desired function of the biofilter. However, plants greater than 30 centimeters (12 inches) tall with long stalks will not filter and may shade desired biofilter plantings. Low-growing weed species such as Bermuda grass (*Cynodon dactylon*) are probably compatible with the functions of the biofilter.

Recommendation: The Biofilter Saltgrass Sod Planting and Maintenance Specification 3.0(G-H) requires removal of weeds during the maintenance period. This activity may need to be extended beyond the maintenance period to prevent the establishment of species that would degrade the function of the biofilters. Plantings should be monitored beyond the maintenance period to determine whether weed removal is necessary. If problems are observed, Caltrans should identify potentially invasive weeds and develop a strategy for removal.

3.1 INTRODUCTION

Although initial performance of some saltgrass plantings experienced problems, vegetative cover at all of the sites substantially improved between May and August 1999 (Walker 1999). This improvement is attributed to several factors, including:

- remedial plantings;
- installation of temporary irrigation systems;
- warmer temperatures; and
- age of plantings.

The recommendations offered in Section Three highlight some of the successful measures that have been implemented already and additional actions that may be beneficial to future installations. This section also presents a list of potential growers, delivery times, and costs for plant material.

3.2 METHODS FOR FUTURE BIOFILTER INSTALLATIONS

Future biofilter installations will benefit from the lessons learned from the current installations. Our review of plant selection, plant propagation, planting installation, and maintenance has identified the following issues to be considered for future installations:

- Plant selection
- Timing of planting
- Maintenance requirements

Constraints imposed on the BMP Retrofit Pilot Program made it necessary to find sites to place biofilter installations. Future installations would be selected based on matching the appropriate technology to a site needing storm water remediation. Therefore, this section does not address recommendations for site selection, but provides information on how to establish biofilters in conditions that are typical of Caltrans rights-of-way.

The following sections summarize our recommendations to address each of the issues of plant selection, timing of planting, and maintenance requirements.

3.2.1 Plant Selection

A list of species was compiled that met specific functional criteria required for the BMP Retrofit Pilot Program's biofiltration installations. This list was subsequently reduced to a single species because of planting requirements. Ultimately, saltgrass was selected because it was a perennial and because it could be grown as sod. As discussed in Section Two, the decision to use sod was based on the false assumption that it would result in greater initial cover with shorter lead-time. Saltgrass is typically dormant during the winter and therefore establishment is delayed until after the first winter. If saltgrass is planted in the fall, it is not likely to be fully established or functional as a biofilter until the following fall. If saltgrass is planted in the spring and irrigation

is provided, it is likely that the planting would be fully functional by the fall of the same year. But in all cases the lead time between ordering the sod and achieving a functional biofilter is probably more than 12 to 15 months. Therefore, other types of plantings (e.g. plugs, stolons/rhizomes, or seed) and species mixes should not be precluded based on lead time.

The decision to select saltgrass overlooked other species that may be appropriate. Table 2-3 lists some of the species originally identified by RBF for biofilter plantings and others that may also meet the functional criteria defined by RBF (1999):

- Filter suspended solids in runoff from paved areas;
- Withstand one-year storm events (flow);
- Adapt to climate conditions within Caltrans Districts 7 and 11;
- Tolerate periods of both high and low soil moisture;
- Low-growing (to maintain structure under flow conditions); and
- Require little maintenance (mowing, watering, and fertilization).

All of the species listed in Table 2-3 are capable of filtering suspended solids. Some species may require mowing to maintain the desired height. Various plant combinations may have different pollutant removal capability, however there is no existing performance data for the species listed in Table 2-3. Experimental design of future biofilter installations would be useful to evaluate how different combinations perform. This data would help guide future statewide deployment of biofiltration technology.

The species in Table 2-3 are generally cool season grasses or herbs that can be planted from plugs or seed. Some of them produce rhizomes like saltgrass that might permit them to be grown as sod. These species typically grow during the cool winter months when filtering functions are required.

An example of one potential plant mix composed of cool season species is provided in Table 2-2. Additional studies should be conducted to determine how these species could be propagated and planted in biofilters. An experimental approach would benefit future biofiltration installations. The performance of various species combinations could be compared for cost, removal of target constituents, and long-term maintenance.

3.2.2 Timing of Planting

The saltgrass installed during 1998-99 was established at the nursery late in the growing season. Cool temperatures and sparse precipitation resulted in poor performance of the plantings during the late winter and early spring. The lack of significant precipitation in the region shortly after the plantings were installed in December and February 1999, and the cool temperatures that persisted from January to mid-May 1999 are illustrated in Figure 3-1. However, all of the plantings have substantially improved with irrigation and warm temperatures from May to July 1999.

Table 3-1 summarizes the timing requirements and minimum lead times for future saltgrass and non-saltgrass plantings. Future saltgrass plantings should be ordered at least one year in advance. Seeds or cuttings should be planted at the nursery no later than June 1 to take advantage of the

warm growing season. These plants could then be delivered and planted at the biofilter site in September or October. Later plantings are not recommended because they would not have time to become established before the onset of cool temperatures. Sod that is not established is at risk of being damaged by high flows that scour and dislocate the plantings. Alternatively plantings should be installed in spring at the start of the growing season.

All saltgrass plantings should be given supplemental irrigation for approximately one year following installation to supplement rainfall.

3.2.3 Maintenance Requirements

The maintenance criteria included in Appendix G of the Quarterly Status Report No. 5 should be modified to include monitoring before and after the growing season. Additional remedial saltgrass plantings should be installed only during the growing season and with provision for irrigation. Alternatively, bare areas could be overseeded with a cool season planting mix of species (Table 2-2).

As discussed in Section Two, vegetative debris, including leaf litter, bark, and branches, should be periodically removed from the biofilters. Without maintenance, vegetative debris could accumulate on the plantings, shading them and causing dieback or mortality.

All plantings have the potential to be invaded by invasive weeds. Some weed species may be compatible with biofilter functions, but others could compete with the plantings for light and water and may degrade the function of the biofilters. We recommend that biofilter sites should be monitored to determine whether weed control is necessary. If a problem is identified, a strategy for long-term management of weed species should be developed and implemented.

Long-term (6-12 month) performance standards, as recommended in Appendix H of the Quarterly Status Report No. 5, would help ensure contractor responsibility for planting establishment.

3.2.4 Future Strategies

For future installations we recommend that experimental opportunities be explored for alternative approaches to establishing and maintaining vegetation in the biofilters. The following approaches are recommended for evaluation:

- Test soil and apply appropriate amendments, mulch, and fertilizers prior to planting;
- Use of different types of plant material for remediation of bare spots (e.g., plugs, seed, stolons, and sod);
- Combinations of warm season and cool season grasses; and
- Use of the originally proposed mix of grasses in those sites that vegetation has not held or where weed control has become a problem.

Evaluation of the performance of these plantings would provide useful information for the establishment of future biofilter installations. Statewide deployment of biofilter technology will need to address the variables of temperature, precipitation, and soils that might be encountered. These variables can be better addressed if a range of species, planting, and maintenance techniques are evaluated.

3.3 POTENTIAL GROWERS AND PRICE INFORMATION

Table 2-3 lists plant species that may be suitable for biofilter installations in Caltrans Districts 7 and 11. We have compiled a list of sources for this plant material that includes seed suppliers and growers.

Seed for the species listed in Table 2-3 is available from the following suppliers:

- **Pacific Coast Seed,** Contact: David Gilpin, T 925-373-4417, F 925-373-6855.
- **S&S Seeds**, Contact: Victor Schaff, T 805-684-0436, F 805-684-2798.

Potential growers that can supply established plantings for biofilter installation include:

- **Tree of Life Nursery**, Contact: Jeff Bohn, T 949-728-0685.
- **Greenlee Nursery**, Contact: John Greenlee, T 909-629-9045, F 909-620-9283.
- **Sherman Nursery**, Contact: Jim Sherman, T 760-471-9988, F 760-471-9578.
- **Cornflower Farms**, Contact: Amelia or Jeff, T 916-689-1015, F 916-689-1968.
- **Bee Valley Nursery**, Contact: Steve Updike, T 619-468-3459.

Table 2-3 lists the cost of the plant material from each of the seed suppliers and growers that provided estimates.

3.4 REMEDIATION OF CURRENT BIOFILTRATION SITES

Increased vegetation coverage has been attained since the sites were reviewed on May 18, 1999. Increased temperatures, irrigation and remedial plantings are probably the factors that have contributed to the increased cover. It is likely that all of the sites will attain nearly 90 percent coverage of saltgrass by the beginning of the winter season (Table 2-1).

Remedial plantings of saltgrass plugs, seed, and transplants have been used during the past 2 to 3 months to increase cover at some locations. This approach is appropriate for plantings during the growing season. However, a modified approach is recommended if remedial plantings are required after October 1999.

In the event that the saltgrass does not provide adequate coverage of a biofilter site, bare areas should be replanted in the fall with saltgrass from flats, sprigs or transplants. In addition, bare areas can be overseeded with the cool season mix provided in Table 2-2, which was recommended by Pacific Coast Seed (Gilpin 1999). The cool season plants in this mix would provide interim filtration functions for those areas that were bare. It is anticipated that in the next warm growing season, the remedial saltgrass plantings will emerge from dormancy and become established in those areas that were bare the previous year.

While overseeding, it is important to ensure good contact between seed and soil. The site should be irrigated with 13 millimeters (0.5 inch of water) every week unless there is sufficient natural rainfall to allow the seeds to germinate and establish themselves.

Physical erosion controls will be necessary to protect seeds for at least 75 days after the first rainfall of the season. Examples of such controls could include Caltrans Type D erosion control

or placement of a blanket or other biodegradable cover over the seeded portion of the site. Use of a blanket or heavy mulch would help trap moisture and minimize washout potential for seeds.

3.5 CONCLUSIONS

The Caltrans BMP Retrofit Pilot Program included a total of six biofiltration swale installations: four in District 7 and two in District 11. Three biofilter strips were installed: two in District 7 and one in District 11.

The BMP Maintenance Indicators require remedial action if biofilter plantings fail to achieve 90 percent cover. Monitoring results from May 18, 1999 indicated very low values for percent cover. Individual cover ranged from a high of 90 percent to less than 20 percent. The average cover was approximately 50 percent. Remedial actions implemented to address the low cover included increased irrigation, installation of additional plantings in bare areas, and the application of Gro-Power "Plus" fertilizer. These activities and the warmer summer temperatures have increased cover at all of the sites to approximately 90 percent (Table 2-1).

Problems that contributed to the poor initial performance included the lack of adequate lead time for the grower to propagate the plant material, installation of plantings during the cool season when the saltgrass plants were dormant, and the lack of adequate irrigation for the plantings. However, these problems have been addressed and largely overcome. The recommendations contained in the Quarterly Status Report No. 5 and the recommendations outlined in this report will help to avoid or minimize some of the problems encountered during 1998-99.

We recommend that future installations be approached experimentally. The objectives of the retrofit pilot studies include evaluation of constituent removal efficiency, technical feasibility, and the cost of retrofitting Caltrans facilities with pollution control measures. According to the Scoping Study, the aim of the specific site selection was to assure that data collected in the programs are accurate and transferable. While the accuracy of the data to be derived from the projects is assured through correct documentation and monitoring, the data may be transferable only in as much as the program design, its diagnostic techniques, and replicability allow.

Evaluation of different approaches to plant selection, timing of planting, and maintenance will further the objectives of the pilot study. Pilot project design parameters were based on the available literature on the biofilter technology. However, the literature is not conclusive on many issues. Localized factors such as climate, constituents in the runoff, soil, and selection of plant species vary from experiment to experiment. This makes it hard to apply the results in other locations without prior understanding of how local elements in Districts 7 and 11 will affect BMP performance.

The program, however, is amenable to derive "lessons learned" in terms of appropriate decision-making, and factors that affect the feasibility and performance of the BMPs.

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Walsh, P.M., M.E. Barrett, J.F. Malina, and R.J. Charbeneau, 1997. Use of Vegetative Controls for Treatment of Highway Runoff. Center for Research in Water Resources, The University of Texas at Austin, Online Report 97-5

Young, G.K., S. Stein, P.Cole, T. Kammer, F. Graziano and F. Bank, 1996. Evaluation and Management of Highway Runoff Water Quality. FHWA-PD-96-032, Federal Highway Administration, Washington, DC.

Table 2-1
Summary of Biofilter Site Characteristics

									Biofilter Sod Installation Information							Post-Installation Activities					Irrigation[1]									Biofiltration Site Selection Matrix			
																														Weight=5	Weight=8	Weight=9	Weight=10
Site Name	Site ID	Caltrans District	Length (m)	Width (m)	Slope	Biofilter Surface Area (m^2)	Tributary Area (m^2)	Nursery Source	Date	Date of Construction Completion	Surface Area of Installed Sod (m^2)	Sod Coverage at installation	Coverage at 5/15/99[1]	Coverage at 7/12/99	Coverage at 7/28/99	Hydroseed (6lbs/acre) Date	Hand Broadcast Seed Date	Supplemental Sod Date	Plug Date	Fertilization with GroPower Plus	Original Irrigation Schedule (carried out by contractor)	April schedule	May & June Schedule	July Schedule	Current Irrigation Schedule	Vector Activites	Stormwater Monitoring/ Sampling Start Date	Shading	Substrate	Disturbance	Estimated Soil Type	Estimated Tributary Area	Length	Slope
Altadena Maintenance Station Biostrip	73211a	7	20.0	8.0	none	159.9	6718.0	Tree of Life	2/22/99	3/12/99	91.4	10%	40%	not obs.	90%	3/29/99	N/A	N/A	N/A	7/30/99	Three times per week through 3/12/99 (sites were not watered from 3/12 - 3/29/99 because of precipitation)	Three times per week	Five times per week	Three times per week	Twice per week	spreader ditch upstream of strip contained standing water (at beginning of June)	10/1/99	no			9	8	7	8
I-605/SR-91 Interchange Biostrip	73222a	7	60.0	8.0	none	479.7	1902.1	Tree of Life	2/23/99	3/12/99	517.6	10%	90%	100%	90%	3/29/99	8/2/99 (where transplant vegetation was obtained for the Del Amo site)	N/A	N/A	7/30/99		Three times per week	Five times per week	Three times per week	Twice per week for established vegetation; three times per day for seeded	mosquito larvea treated with Vectolex (wk of 5/31/99)	10/1/99	no	Sandy loam	none	8	2	10	9
I-605/SR-91 Interchange Bioswale	73222b	7	40.0	1.5	4:1	109.9	849.9	Tree of Life	2/24/99	3/12/99		10%	70%	100%	90%	3/29/99	N/A	N/A	N/A	7/30/99		Three times per week	Five times per week	Three times per week	Twice per week	mosquito larvea treated with Vectolex (wk of 5/31/99)	10/1/99	no	Sandy loam	gophers	8	2	10	9
Cerritos Maintenance Station Bioswale	73223	7	20.0	1.5	2:1	43.7	1740.2	Tree of Life	2/24/99	3/12/99	30.4	10%	30%	85%	90%	3/29/99	N/A	N/A	7/15/99	7/30/99		Three times per week	Five times per week	Three times per week	Twice per week	energy dissipator contained standing water (06/99)	10/1/99	no		gophers	6	3	9	8
I-5/I605 Bioswale	73224	7	40.0	2.0	2:1	107.3	2630.6	Tree of Life	2/24/99	3/12/99	182.7	10%	<20%	not obs.	85-90%	3/29/99	N/A	N/A	7/22/99	7/30/99		Three times per week	Five times per week	Three times per week	Twice per week (duration: 10 minutes)	dense populations of mosquito pupae treated with Golden Bear oil	10/1/99	no			8	3	8	9
I-605/Del Amo Bioswale	73225	7	54.0	1.0	2:1	90.9	2792.4	Tree of Life	2/24/99	3/12/99	106.5	10%	<20%	30%	90%	3/29/99	N/A	7/26/99 &7/27/99 (Transplant obtained from Biostrip)	7/22/99	7/30/99		Three times per week	Five times per week	Once daily	Once daily	energy dissipator contained standing water (06/99); mosquito larvea treated with Vectolex (wk of 5/31/99)	10/1/99	Tree shades 25% of site	Sandy loam		6	2	10	10
Melrose Ave/SR-78 Bioswale	112205	11	112.0	var 3.0 - 6.0	2:1	680.2	9712.8	Tree of Life	12/8, 12/9, 12/14, & 12/19/99	2/26/99	768.3	60%	50% (dormant sod has greater coverage)	50 - 100% n=80%	90%	3/22/99	4/30/99	6/22/99 & 6/23/99	N/A	Est. 8/11/99	Contractor hand watered as needed through 2/26/99	03/99-04/99 Three times per week	Five times per week	06/28-07/10/99 Five times per week; 07/11-07/17/99 Twice per week; 07/18-07/31/99 once per week (duration: 45-50 minutes)	Twice per week (on the same day; duration: 30 minutes)	site was visited by SD vector control May 12, 99	10/1/99	Eucalyptus	Sandy clay	None	5	7	8	7
I-5 Palomar Airport Rd. Biostrip	112206	11	North: 39.3 Central: 23.5 South: 48.5	North: 2.6 Central: 1.5 South: 2.7	2:1	408.2	9389.0	Tree of Life	6/16 & 6/17/99	6/29/99	330.4	100%	coverage of flats at nursery on May 16 was 60%	95%	90%	N/A	N/A	N/A	N/A	Est. 8/11/99	Twice daily to present	NA	NA	06/28-07/10/99 Once daily (2AM); 07/11-07/31/99 Twice daily (2AM, 12PM) (duration: 15 minutes)	Twice daily (duration: 15 minutes)		10/1/99	Eucalyptus and Pine	Sandy loam	As of 8/3/99: an insect eating the salt grass lvs; juvenile grasshoppers suspected; appeared to be recovering as of 8/17/99	9	8	10	8
Carlsbard Maintenance Station Biostrip & Infiltration Trench	112207	11	West: 6.0 East: 5.6	West: 26.3 East: 25.0	none	298.4	2671.0	Tree of Life	12/26/99	2/26/99	243.3	60%	70%	50 - 70%	85-90%	3/22/99	4/30/99	6/23/99	N/A	Est. 8/11/99	Contractor hand watered as needed through 2/26/99	03/99-04/99 Three times per week	Five times per week	06/28-07/10/99 Five times per week; 07/11-07/17/99 Twice per week; 07/18-07/31/99 once per week (duration: 20-30 minutes)	Twice per week (on the same day; duration: 20 minutes)	site was visited by SD vector control May 12, 1999	10/1/99	Eucalyptus	Sandy loam	Rabbit fence installed 6/21/99; substantial recovery noted	10	6	6	8

[1] Unless otherwise indicated, sites were irrigated in sections until water was seen ponding. After water was absorbed this procedure was repeated.

Data for this table was obtained with the help of Robert Bein, William Frost and Associates and Kinnetic Laboratories Inc.

Table 2-2
Potential Cool Season Plant Mix for Use at Biofilter Sites

Species	Common Name	PLS lbs per acre[1]	Cost per Pound ($)[1]	
			Pacific Coast Seed	S & S Seed
Triticum x Elymus	regreen hybrid wheatgrass	18	4	5
Hordeum brachyantherum	meadow barley	8	19	20
Nasella pulchra (N. lepida in drier locations)	purple needlegrass	6	65	65
Leymus triticoides	creeping wildrye	4	28	30
Trifolium wildenovii	tomcat clover	4	48	40

[1] English units provided for consistency with units used by suppliers

Table 2-3
Plant Species Suitable for Biofiltration

Species	Common Name	Native	Height cm (inches)	Annual v. Perennial	Regional Wetland Indicator	Habitat	Price ($) per PLS lbs[1]		Price ($) per 1.5"x 3" plug[1]							Price ($) per 2.25"x 3" rose pot[1]		Price ($) per 2.25"x 5" tree band[1]
									Cornflower Farms[2]						Tree of Life[3]			
							S&S Seed	Pacific Coast Seed	10,000 +	5,000-9,800	2,600-4,800	1,200-2,400	600-1,000	200-400		Cornflower Farms[2]	Tree of Life[3]	Cornflower Farms[2]
Agrostis pallens	seashore bentgrass	yes	10-70 (3.9"-27.6")	perennial	NI	meadows, woodland	45	45										
Bromus carinatus	California brome	yes	45.7-91.4 (18-36)	perennial	NI	open shrubland, woodland	9.25	8.5							0.32		0.58	
Deschampsia cespitosa	tufted hairgrass	yes	30.5-76.2 (12"-30")	perennial	FACW	wet sites, meadows, coastal marshes, forests, alpine	32	39.5	0.12	0.14	0.17	0.20	0.26	0.31	0.32	0.67	0.58	1.45
Elymus glaucus	blue wildrye	yes	15.2-50.8 (6"-20")	perennial	FACU	open areas, chaparral, woodland, forests	14	13.5	0.12	0.14	0.17	0.20	0.26	0.31	0.32	0.67	0.58	1.45
Festuca rubra	red fescue	yes	30-80 (11.8-31.5)	perennial	FAC	sand dunes, grassland and subalpine forests	2	15	0.12	0.14	0.17	0.20	0.26	0.31		0.67		1.45
Glyceria elata	tall (or fowl) mannagrass	yes	60-150 (23.6"-59")	perennial	OBL	wet places	<10	N/A										
Hordeum brachyantherum	meadow barley	yes	30.5-45.7 (12"-18")	perennial	FACW	meadows, pastures, streambanks	20	19	0.12	0.14	0.17	0.20	0.26	0.31		0.67		1.45
Leymus triticoides Rio	creeping wildrye	yes	45.7-91.4+ (18"-36"+	perennial	FAC+	moist, often saline, meadows	30	28	0.12	0.14	0.17	0.20	0.26	0.31	0.32	0.67	0.58	1.45
Lolium perenne	perennial rye	no	50-80 (19.7"-31.5")	perennial	FAC*	disturbed sites, abandoned fields, lawns	2	2										
Lupinus bicolor	pygmy-leaf lupine	yes	10.2-30.5 (4"-12")	annual	NI	open or disturbed areas	38	40							0.45	0.67	0.65	1.45
Nasella lepida	foothill neddlegrass	yes	30.5-61 (12"-24")	perennial	NI	dry slopes, chaparral, oak grassland	400	225	0.12	0.14	0.17	0.20	0.26	0.31	0.32	0.67	0.58	1.45
Nasella pulchra	purple needlegrass	yes	30.5-61 (12"-24")	perennial	NI	oak woodland, chaparral, grassland	65	65	0.12	0.14	0.17	0.20	0.26	0.31	0.32	0.67	0.58	1.45
Trifolium wildenovii	tomcat clover	yes	10.2-40.6 (4"-16")	annual	NI	disturbed, generally spring moist, heavy soils, sometimes serpentine	40	48										
Triticum x Elymus	regreen hybrid wheatgrass	no	38-61 (15"-24")	annual	NI	N/A	5	4										

[1] English units provided for consistency with supplier specifications.
[2] Cornflower Farms requires approximately 8-12 weeks lead time.
[3] Tree of Life nursery requires 3 months lead time for creeping wildrye and pygmy-leaf lupine and 4 months lead time for other available species.

Table 3-1

Recommended Schedule for Future Biofilter Plantings

Type of Planting	Date to Order Seed or Nursery Material	Planting Date	Irrigation Period
Saltgrass (from sod or plugs)	Late Spring to Early Summer	Late Summer to Early Fall **OR** Late Winter to Early Spring	As necessary during first year after planting. Important to water during first growing season (late spring to early fall).
Cool Season Plant Mix (from seed)	Summer	Late Fall to Early Winter	As necessary during late fall, winter, and early spring to supplement rainfall.
Cool Season Plant Mix (from plugs or sod)	Late Spring to Early Summer	Late Fall to Early Winter	As necessary during late fall, winter, and early spring to supplement rainfall.

Figure 2-1. Palomar Airport Road Site, July 12, 1999

Figure 2-2. Carlsbad Maintenance Station, July 12, 1999

Figure 2-3. Melrose Avenue/SR 78 Site, July 12, 1999

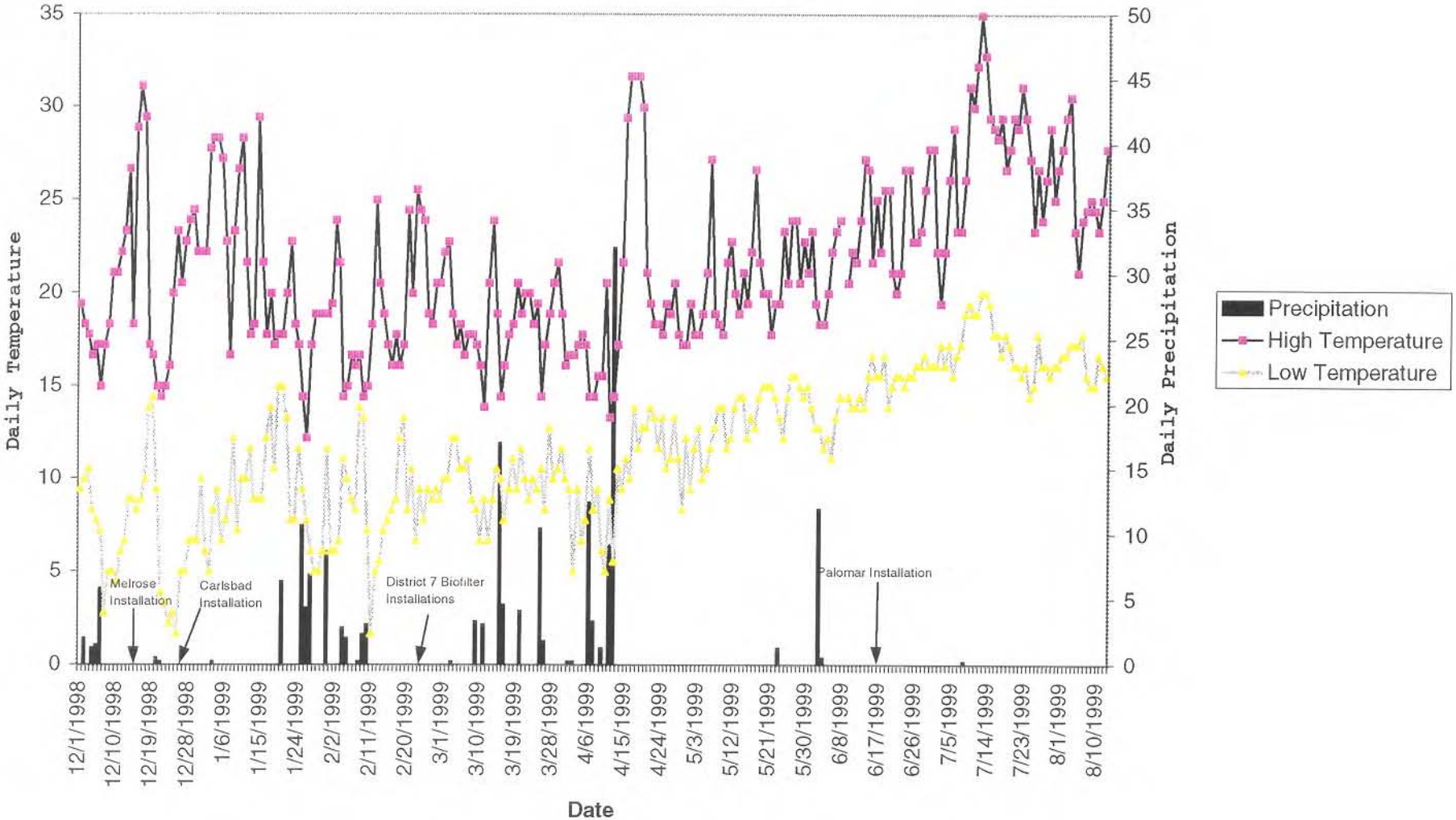
Figure 2-4. Cerritos Maintenance Station Site, July 12, 1999

Figure 2-5. I-605 at State Route 91 (swale in foreground and strip in background), July 12, 1999

Figure 2-6. I-605 at State Route 91 (biofilter strip), July 12, 1999

Figure 2-7. I-605 at Del Amo, July 12, 1999

Figure 3-1
Daily Temperature and Precipitation Data
at Long Beach, CA 12/01/98-08/12/99



Appendix A

Records of Personal Communications

Appendix A

Telephone conversation with Jeff Bohn of Tree of Life Nursery
August 10, 1999
949-728-0685

RE: Saltgrass sod growth

- Major problem with sod growth for the biofilter sites was timing. Order was received late in the growing season (third week of August) for saltgrass and cuttings for flats were taken too late. Some flats were grown from seed. Those did better than the other flats grown from cuttings. Optimally, Tree of Life would start growing flats in May and deliver them in August to be planted. This would allow the nursery to grow the flats during the grass' natural growing season.

- Also touched on the fact that success was being looked for too early. As saltgrass is a warm season grass one should be careful not to judge success before the sod has had the advantage of at least one growing season.

- Jeff also suggested planting stolons instead of sod. This method would not provide immediate full coverage as sod should but it would be a less expensive option. If a future biofilter site did not require immediate cover this may be an option. A grower could field-grow saltgrass and then dig up stolons just prior to when they were coming out of dormancy. The stolons could then be planted and have a full growing season to get established. Jeff estimated it may take a year before a site is completely covered (this would depend on how densely they were planted). Although Tree of Life had experience field growing another species of Distichlis for a project at Owens Lake, they are not set up for that kind of growing and would therefore not be interested in providing field-growing services for saltgrass. Jeff suggested looking for "grass growers" in the area.

- Possibility of seeding but seeds would need to be treated because of dormancy factor. Not sure what success rate would be.

- To find out pure live seed specs for saltgrass seeds used to grow flats call S&S Seed.

- When asked to comment on possibility of complementing saltgrass with cool season grasses Jeff was not sure if other grasses would be able to get established because of saltgrass' dense root system. One suggestion was *Muhlenbergia rigens*.

Appendix A

Telephone conversation with John Andrew of Robert Bein, William Frost & Associates
August 11, 1999
949-472-3505

RE: Saltgrass sod

- Spoke with John Andrew about the difficulties encountered with respect to the saltgrass sod. Caltrans needed immediate cover and therefore it was decided that saltgrass flats would be grown. This is a new way of growing saltgrass and therefore most nurseries had limited experience with this type of growth. John tried to contact some sod growers to get saltgrass in traditional sod format but none repsonded to his calls. He assumes that most would not be interested because it is not regularly grown as sod and therefore there is no tested procedure for growing such sod.

- John reiterated information given to me by Tree of Life. Flats were planted around September 1, which is late in the growing season. Flats that were grown from seed did better than those grown from cuttings (Jeff Bohn mentioned that cuttings were taken too late in the growing season). Flats grown from cuttings were then overseeded but this did not help very much. The District 11 sites that were installed in December got the better flats. District 7 flats were in very poor condition.

- If this same exact situation had to be repeated, he would suggest planting the flats with seed only and growing the flats in a greenhouse, thereby allowing temperature to be controlled.

- Other factors affecting early saltgrass establishment once flats were installed:

  -cold temperatures lasted into spring this past year, delaying growing season
  -rainfall was below average for late winter/early spring

- Optimally, if Caltrans did not require immediate coverage, saltgrass could be planted as stolons, plugs and/or seeds and show good success as long as timing was right. Good times to plant would be late winter/early spring (February, March, April) or alternatively at the end of the summer.

Appendix A

Telephone conversation with Bob Wu of Caltrans District 7
August 6, 1999
Phone: 213-897-8636
Pager: 916-506-9018

Was referred to Bob Wu by Marcelo Peinado

RE: Irrigation of District 7 sites and nurseries

- Altadena maintenance station is manually irrigated. The site was actually getting too much runoff and water had to be diverted. Some flooding occurred during heavy rains. It was assumed that flooding was inhibiting saltgrass growth. Now that site is drier, it is looking better and doing nicely. This site received poor quality sod.

- Del Amo site's water source got cut off as a result of construction activites up the road. Site is watered manually from water tank on pick-up truck.

- The I-5/605 site has an automatic sprinkler system.

- RBF provided Caltrans with a list of possible nurseries to grow reserve saltgrass sod. Most were not interested because it was only for around 1000 square feet and some did not want the liability associated with such a project. He gave me the names of three nurseries over the phone.

- We discussed the poor quality of the saltgrass sod. He mentioned that the nursery may not have been experienced enough with growing saltgrass flats. District 11 flats were of better quality than District 7 flats.

Appendix A

Telephone conversation with Emilio Villaramontes of Caltrans – District 11
July 29, 1999
619-688-4255

RE: General information regarding District 11 biofilter sites

- Initial estimate for irrigation was $10,000 so decision was made to irrigate manually. Manual irrigation did not seem to be doing the job though, not enough water.

- Melrose site: Eucalyptus tree was shading the swale, leaves falling, little oversight on this site, temporary above ground irrigation now.

- Carlsbad site: A Eucalyptus tree is also present at this site but did not seem to bothering success of the swale.

- Cannon Rd site: Pines present along side of freeway, presently has automatic irrigation system

- No original soils to be found at any of these three sites. Soil can be characterized as duff.

- Suggested trying to plant saltgrass stolons and utilizing a mycorrhizal root dip inoculant.

- Flats were obtained from Tree of Life nursery but Emilio ordered extra from Bee Valley Nursery for the La Costa site, quality was very good.

- Referred me to Harold Lentis for information on Cannon Rd site and to Anna Walker for information on Melrose and Carlsbad sites.

Appendix A

Telephone conversation with Cathy Hunter of Caltrans District 11
August 5, 1999.
619-467-4084

RE: Palomar Airport Rd. site

- Site was planted with square flats with 1" spaces in between the flats. Sand was placed in the spaces between the flats.

- Overhead irrigation three times per day, once at night and twice during the day. This regime has been followed since shortly after installation.

- Coverage of flats was very good, they were well developed.

Appendix A

Telephone conversations with David Gilpin of Pacific Coast Seed nursery
August 6, 10, 12, 1999
925-373-4417

RE: Suitable vegetation for biofilter sites

- Two planting options suggested:
    - spring planting : Plant saltgrass from either flats, plugs, sprigs, or seed, planting should occurs after big gully washes to minimize risk of the saltgrass being washed away. If saltgrass does not provide full coverage, bare areas can be replanted in the fall and then overseeded with a cool season mix. If saltgrass coverage of a site is too thin to provide filtration of run-off, the site should be overseeded with a cool season mix in the fall. It is important to ensure good contact between seed and soil. The site should be irrigated to allow for establishment unless there is sufficient natural rainfall to allow the seeds to germinate and establish themselves. If the saltgrass stands are dense then no additional treatment would be needed.

    - fall planting: Plant both saltgrass and cool season plants in the fall. Just at the start of the rainy season established plants should be overseeded with the a cool season mix. The site should then be irrigated until the seeds are established or until natural rainfall is adequate to sustain growth.

- In all cases physical erosion controls would be necessary to protect seeds for at least 75 days after the first rainfall of the season. Use of heavy mulch would help trap moisture and minimize wash out potential for seeds.

- Also discussed was whether saltgrass will provide filtering function when it is dormant.

Appendix A

Telephone conversations with Anna M. Walker of Robert Bein, William Frost & Associates
August 6, 1999 and during week of August 9, 1999.
949-472-3410

RE: Irrigation schedules at biofilter site

- Anna Walker provided information on irrigation schedules and dimensions of the biofilter sites as well as other general useful information. Most of this information is contained in Table 2-1.

- Palomar Airport Rd. site: problem with leaves being eaten (week of August 2), not sure what the cause is. (8-27-99: further investigation suggests that the damage may be due to juvenile grasshoppers; saltgrass was recovering on 8/17/99 where irrigation is adequate)

- Suggested including information on precipitation and temperature. This past winter and spring were quite cold. Also there was not enough rain in the winter after sites were installed but heavy rains occurred in spring which washed away some of the unestablished vegetation.

- I605/SR91 biostrip site: Transplant plugs were taken from this site; donor areas were seeded to help them recover. This portion of the site is irrigated with a sprinkler system.

- Del Amo site: This site is against a retaining wall. As a result it is very windy and dries up quickly so it needs more water than other sites.

- I5/605 site: Caltrans automatic irrigation system used for watering. It is on a timer and site is irrigated for 10 minutes at a time.

- Duration or quantity of irrigation given to most sites was not tracked. For most of District 7 sites (except I5/605 and portion of I605/SR91 site) site is watered manually in sections. Each section is watered until water starts to pond. This procedure is repeated once. This is also the method used for irrigation of Melrose and Carlsbad sites until Kinetic Labs took over.

- Opinion on different planting methods: Hydroseeding, plugging and adding supplemental sod obtained from Tree of Life Nursery worked very well. The transplanted vegetation at the Del Amo site went from 100% green pre-transplantation to 50% green, but it looks like it is coming back. Problem is the amount of severed roots. Supplemental sod in District 11 had root system intact so it did well. As of yet **no germination** has been seen from hand broadcast seeding.