Habitat Monitoring Report: Year 1
City of Tacoma Middle Waterway Restoration Project

AND PICKLEWEED FOREST

Salicornia virginica

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Habitat Monitoring Report: Year 1
City of Tacoma Middle Waterway Restoration Project

1.0 Introduction

The City of Tacoma (City) performed a habitat restoration on 1.9 acres of vacant industrial property at the head of Middle Waterway in Tacoma, Washington. The property is located near the intersection of East F Street and East 11th Street. The primary objectives of the restoration action were to lower the grade of the properties to salt marsh elevations, cover the surface with clean habitat material, and vegetate the salt marsh and its bordering riparian buffer zones.

This restoration action was conducted as part of the City's settlement of alleged natural resource damages with the Commencement Bay Natural Resource Trustees[1] (Trustees). This monitoring report is being provided to the Trustees as a part of that settlement.

Restoration activities included construction (excavation, backfilling, grading, slope stabilization, fencing, and installation of an irrigation system) performed by RCI Environmental, Inc. between July 21 and September 29, 2000; planting of all the riparian areas by the City and citizen volunteers on November 4, 2000; and planting of salt marsh areas on May 26, 2001.

The City has conducted a monitoring event each quarter since completion of construction: Year 0 - December 21, 2000; March 29, 2001; June 26, 2001; August 15, 2001; Year 1 - December 11, 2001; March 21, 2002; June 14, 2002; and August 20, 2002. The methods and frequency of these monitoring events were detailed in the "Monitoring and Adaptive Management Plan" (MAMP) (Hart Crowser, February 25, 2000) prepared for this site. The first three monitoring events of each year are qualitative, however, the fourth event is quantitative as per the MAMP.

1.1 Physical Site Description

The site is composed of three general areas: the City parcel, the DNR parcel and the 11th Street Right of Way (ROW).

The City parcel is approximately 1 acre and is situated adjacent to the substation on along East "F" Street. The riparian area (elevation > 14 ft

[1] Commencement Bay Natural Resource Trustees consist of the following entities: National Oceanic and Atmospheric Administration; U.S. Fish and Wildlife Service; Washington State Department of Ecology; Washington State Department of Fish and Wildlife; Washington State Department of Natural Resources; Puyallup Tribe of Indians and Muckleshoot Indian Tribe.

MLLW) lines three edges in this portion of the site and is sloped at 4:1 (horizontal: vertical). The riparian soil is all imported sandy loam. There is a broad flat upper salt marsh area (elevations between 12 and 14 ft MLLW) and the substrate is native sands and silts/clays that were uncovered during project excavation. The lower salt marsh area (elevations between 12 ft MLLW down to the project boundary, which is approximately 9 ft MLLW) consists predominantly of imported silty sand.

The 0.7-acre DNR parcel follows the irregularly shaped project boundary on the waterside and is bordered by the substation and the Port Yacht Basin on the upland side. All the substrate on this parcel is imported material. The riparian has some broad flat areas in addition to the transitional sloping portion that leads to the salt marsh. Owing to the limiting project boundaries in this area, the upper and lower salt marsh areas are narrow bands following project boundary. All three elevation ranges converge at a relatively steep slope along side the Port Yacht basin.

The 11th Street ROW is approximately 0.2-acre strip of riparian area that starts at the end of the Port Yacht Basin Property and stretches along East 11th Street. All of the soil is imported riparian topsoil.

2.0 Qualitative Monitoring & Results

Qualitative monitoring results are based upon observations of trained personnel during site visits and recorded by hand and digital photos. Qualitative observations were taken of vegetation, sedimentation, wildlife, and other general observations. For the City of Tacoma, these personnel are John O'Loughlin, Project Manager and Desiree Pooley, Water Quality Technician. The City has retained David Adams as a site steward, and his observations are also included.

2.1 Photo Points

Photo points were established as described in the MAMP and depicted in Figure 1. The location of each point was marked by a stake and surveyed. A digital photo was taken from each photo point during each monitoring event. Year 1 photos are presented in Appendix A by photo point location.

The photos of the riparian areas show the general good health and vigor of the riparian plantings, as well as the development of volunteers, which are quite extensive in areas. Generally, the slopes tend to have fewer volunteers than the flat riparian areas. This is likely due to the preferential fall out of source seeds on the flats rather as opposed to the slopes.

Photos of the upper and lower salt marsh areas show a large amount of growth within the goose exclusion boundaries. Particularly in the upper salt marsh

areas during the June 14, 2002 monitoring effort, white sweet clover was the most dominate foliage. Shortly thereafter the Washington Conservation Corps crew (co-sponsored by the City of Tacoma) trimmed the clover back as reflected in the August 20, 2002 monitoring photos. Complete removal was not performed due to the proximity of the native plants and their root systems, as well as the fact that sweet clover fixes nitrogen.

2.2 Vegetation

Several general trends have been observed over the course of Year 1 monitoring events:

- Nootka rose, alder, and hooker's willow continue to thrive.
- Pickleweed is growing very well in the lower salt marsh.
- Salt grass in the upper salt marsh is spreading rapidly via rhizomes.
- Virtually all of the initial plantings of fleshy jaumea have been lost to tidal action, predation, or transplant shock.
- Volunteer vegetation is noted in all areas of the project site.
- Only a few of the madrone trees have survived, however, a mature tree near 11th Street has seeded many small saplings nearby that are doing well.
- Evidence of geese and rabbits has been seen within the goose exclusion areas, but no real "damage" has been observed.
- Weeds continue to be present in the riparian areas to a greater extent where the ground is relatively flat as opposed to where the ground is sloped.
- Of the invasive vegetation present prior to construction, blackberry, Scot's broom and knapweed have not re-established to any significant extent.

2.3 Sediment

Certain areas of the restoration site have experienced limited sediment loss since construction was completed. The salt marsh area continues to experience minor erosion (see Appendix A, photo points LM2B). Other erosional areas noted in the first monitoring report (see Appendix A, photo points UM1, UM5, LM1A and B) seem to have equalized with the passage of time and plant growth.

2.4 Wildlife

Many animals have visited the site during Year 1. Direct observations and/or evidence of the following animals have been documented:

- Salmon fry
- Dark-eyed junco
- Crow
- House finch
- Brewer's blackbird
- Seagulls
- Least sandpiper
- Osprey
- Canada geese
- Song sparrow
- King fisher
- Rabbit
- White crowned sparrow
- Robin
- Killdeer
- Rock dove
- Violet green swallow
- Possum or other digging animal

2.5 General Observations

Woody debris deposits have occurred in association with the tides and have been building over time as is apparent in the Quarter 3 and 4 photos for LM1A and B (Appendix A).

Additional naturalized lower salt marsh plant, orache (*Atriplex patula*), is present but did not show up in the quadrat quantitative analysis.

The Middle Waterway Restoration site was chosen as one of six sites for the Commencement Bay Restoration Fish Monitoring effort led by the Northwest Fisheries Science Center. Fish and sediment data was collected from April through October 2002 and summarized in a December 2002 report, "Commencement Bay Restoration Fish Monitoring – 2002 Field Sampling and Data Summary".

3.0 Quantitative Monitoring Methods

Quantitative monitoring involves collection and analysis of numerical data concerning habitat features such as vegetation, sedimentation, and sampling of groundwater seeps if present.

3.1 Vegetation

Quantitative vegetation monitoring for Year 1 was conducted on August 20, 2002. Transects and quadrats established during Year 0 (illustrated in Figure 1) were again monitored.

Twenty-eight sample plots (quadrats) were established at random along the transects. The riparian area contained 8 quadrats (R1 & R2 1 – 4) and ten each were established in the upper (U 1-10) and lower (L 1-10) salt marsh areas. Quadrats L-4, L-5, and L-6 along the lower salt marsh transect and quadrats U-5 and U-7 along the upper salt marsh transect were outside the planted areas. In the riparian area, the size of each quadrat was 28.3 m^2, and in the salt marsh area they each measured 0.25 m^2. The locations of each quadrat were surveyed in and the location information is supplied in Table 1.

Table 1. Quadrat Location Control Readings

Transect / Quadrat ID	Northing	Easting	Elevation	Transect / Quadrat ID	Northing	Easting	Elevation
R1-1	706875	1162073	16.8	U-7	706949	1161668	12.7
R1-2	706856	1162052	16.7	U-8	706875	1161735	13.4
R1-3	706824	1162016	16.5	U-9	706826	1161787	13.2
R1-4	706792	1161975	16.3	U-10	706831	1161799	13.4
R2-1	706880	1161502	15.3	L-1	706876	1161802	11.3
R2-2	706902	1161566	16.6	L-2	706865	1161795	11.4
R2-3	706917	1161604	16.7	L-3	706860	1161760	11.2
R2-4	706934	1161653	17.0	L-4	706898	1161717	11.9
U-1	707070	1161538	13.4	L-5	706981	1161666	11.3
U-2	707035	1161452	13.7	L-6	706984	1161564	11.0
U-3	706905	1161486	13.7	L-7	707008	1161521	11.4
U-4	706903	1161500	13.5	L-8	707009	1161516	11.5
U-5	706913	1161528	13.3	L-9	707034	1161529	10.9
U-6	706916	1161535	13.2	L-10	707042	1161540	10.6

For each quadrat, the Daubenmire cover class (i.e. 0-5%, 5-15%, 15-25%, 25-50%, 50-75%, 75-95% or 95-100%) was estimated for plants found within that quadrat as well as the amount of bare substrate. This data is presented in Table 2. Also in this table are the corresponding Daubenmire cover class midpoint values (i.e. 2.5%, 12.5%, 20.5%, 35%, 65%, 85%, or 97.5%).

Plants were categorized as "native" according to Plants of the Pacific Northwest Coast (Pojar & MacKinnon, 1994). The total native vegetative cover is calculated for each transect.

3.2 Sediment

Quantitative sediment monitoring consisted of recording the sediment elevation at each of 8 sediment stakes. The stakes were installed on October 30, 2000 in the areas shown on Figure 1 and initial readings recorded. Because these stakes were installed shortly after the end of construction it is appropriate to address this reading as Year 2. Each stake was marked in centimeters starting at the top of the stake, however, over time the marks have worn off. During Year 2 monitoring all stakes were read with a tape measure in centimeters from the bottom up.

3.3 Groundwater Seep Sampling

The site was monitored for the presence of seeps throughout each quarterly event, but no seeps have been observed. Therefore, no seep sampling or analysis is possible at this time. We will continue to look for seeps during future monitoring events.

4.0 Quantitative Results

The MAMP established performance goals for the quantitative measures presented in the previous section. These goals were established for 12 months of growth and development. As of August 2002, when the quantitative data was collected, the riparian plants had been in place for 21 months and the salt marsh plants had been in place for only 15 months. Therefore, the observations will be compared with Year 1 performance goals.

4.1 Vegetation

Performance goals for vegetation are split into three categories: Plant Cover, Diversity and Invasive Species.

4.1.1 Plant Cover

Total areal cover within each quadrat and mean percent cover are two measures used to evaluate the successful establishment of the planted areas. Because much of the energy of the first few years of growth is spent on development of below ground biomass the first year's goals should be modest.

The Year 1 performance goals for the riparian area are:

1) Between 20 and 40% areal coverage of native or naturalized non-native plants within each quadrat and
2) Greater than 30% average areal coverage for all quadrats.

Table 2 shows that all riparian quadrats meet the first goal. The range of areal coverage is 35% - 103%, far exceeding the goal range of 20% – 40%. The second performance goal has also been achieved. 132% is the average areal coverage of all riparian quadrats. This number is somewhat skewed by the abundance of grasses, although, even the total native vegetative cover average (59%) exceeds the second goal.

The success of the riparian areas could be attributed to:

- Frequent maintenance and vigilance by David Adams and the City's Washington Conservation Corps crew.
- Lack of disease
- Regular plant irrigation during the dry months

Generally riparian plant growth has been very good. No adaptive management action is warranted due to these results.

The Year 1 performance goals for the salt marsh areas are the same as for the riparian area:

1) Between 20 and 40% areal coverage of native or naturalized non-native plants, and
2) Greater than 30% average areal coverage for all quadrats.

Table 2 shows that eleven of the twenty quadrats (55%) in both salt marsh areas meet the first goal with a range of 20% - 130%. Eight of the eleven quadrats meeting this goal are located in the upper salt marsh area. L-3, L-4, L-5, L-6, L-7, L-8, L-9, U-5, and U-7 do not meet the goal. Of these U-5, U-7, L-4, L-5, L-6 are located outside of the planted areas. However, the combined overall average areal coverage in the salt marsh areas is 38%, which meets the second goal. These numbers are somewhat skewed by the abundance of white sweet clover that predominated much of the upper salt marsh areas.

Potential factors that have affected the progress thus far:

- The vegetation, overall, was in a less developed state when it was planted than had been anticipated when the goal was set.
- The salt marsh areas were planted in defined areas to facilitate goose exclusion device construction; therefore some quadrats are in areas where nothing was planted.
- Much of the energy of the first few years of growth is spent on development of below ground biomass.
- The lack of parent material to facilitate volunteer vegetation.
- Very few of the fleshy jaumea plants survived the first year.

Despite only meeting 55% of performance goal one, with the deficit appearing mostly in the lower salt marsh area, the pickleweed that is present is doing very well.

An adaptive management action based on these results could include planting more lower salt marsh plants. However, additional planting will likely be done as a part of the Middle Waterway Area C superfund cleanup. Therefore no adaptive management is advisable at this time until the superfund process is sorted out.

4.1.2 Diversity

Species diversity is another measure in the ecological evaluation of this project. The long-term goal is for the project site to have a comparable diversity to the original habitat it is trying to recreate. The diversity values provided are targets only and are not criteria by which success will be judged.

The riparian zone diversity target is at least 8 species of native plants present and abundant. Abundant is defined as being present in at least 50% of the quadrats. Applying this definition to the data in Table 2 shows that the following eight riparian plants are abundant on the restoration site: red alder, shore pine, hazelnut, willowherb, nootka rose, hooker's willow, common horsetail and pearly everlasting. Thus, the target diversity value has been achieved.

The salt marsh zone diversity target is at least 3 species of native grasses, sedges, rushes, succulents and broadleaf herbs present. Referring to Table 2, this target has been met due to the presence of the saltgrass, hairgrass and pickleweed.

No adaptive management recommendations are appropriate under this measurement index.

4.1.3 Invasive Species

Areal coverage of invasive species is the final measure used to evaluate the success of this project. As native vegetation matures it is expected to out compete the invasive species.

The riparian zone performance goal for invasive species is not more than 20% areal cover of knapweed, Scot's broom and Himalayan blackberry. Referring to Table 2, the riparian zone has no knapweed, Scot's broom (0.3%) and Himalayan blackberry (1.6%; down from 2.5% in Year 0). Therefore, this invasive species performance goal has been met for Year 1.

However, there is a need to remove other invasive species present on-site. Butterfly bush should be removed to prevent it from crowding out the native plants. Tansy ragwort, morning glory, Himalayan blackberry, St. John's wort, Scot's broom and any other noxious weeds should be removed and disposed of properly to prevent the spread on site and off site.

The salt marsh area performance goal for invasive species is not more than 15% areal cover of invasive plants considered noxious (i.e. *spartina antiflora*). Referring to Table 2, the upper and lower salt marsh zones have few noxious weeds present (as determined by reference to Pierce County and Washington State noxious weed lists). All area coverages of the noxious weeds identified are under 15%. Therefore this invasive species performance goal has been met. Although not on a noxious weed list, white sweet clover will be watched this next year as it dominated the upper salt marsh areas during Year 1.

The adaptive management recommendation under this measurement index is a targeted removal or other means of control (where removal is not beneficial to existing native plants; i.e. sweet clover), of invasive species from both the salt marsh and riparian zones: Canada thistle, St. John's wort, Tansy ragwort, morning glory, Himalayan blackberry, Scot's broom, and butterfly bush.

4.2 Sediment

Erosion of salt marsh or riparian soil substrates could cause loss of habitat and vegetation. However, some equilibration of sediment on-site is expected during the first couple of years. The performance goal for sediment erosion is to have less than 2 cm of erosion between monitoring events for Years 1 and 2. This performance goal may be accurately compared to the Year 2 monitoring data at this point because construction was completed in August 2000 and stakes were placed in October 2000. Table 3 presents Year 2 sediment stake readings, the net change over the year, and the opportunity to compare these readings with the installation value.

Table 3. Sediment Stake Readings for Year 2

Sediment Stake ID	*Installation 10/30/2000*	Yr 2 Qtr 1 12/11/2001	Yr 2 Qtr 2 3/21/2002	Yr 2 Qtr 3 6/14/2002	Yr 2 Qtr 4 8/20/2002	**Year 2 Net Change**
705	*60*	60	60.5	60.3	60	**0**
706	*50*	51	50	50.5	50.5	**-0.5**
712	*50*	50	50.5	49.8	50	**0**
713	*61*	60.5	61	61	60.5	**0**
715	*51*	51	51	50.8	50.5	**-0.5**
716	*51*	51.5	51	51.8	52	**0.5**
719	*50*	50	49.5	49.2	48.5	**-1.5**
720	*50*	48.5	50	47.9	48	**-0.5**

In Table 3, a positive net change corresponds to the sediment getting further from the top of the stake (i.e. erosion) and a negative net change corresponds to the sediment getting closer to the top of the stake (i.e. sedimentation). There was little change observed during Year 2 monitoring efforts. Almost all sediment stakes (706, 715, 719, 720) show small amounts of sedimentation. The accumulation of sediment may be attributed to continued tidal action and equilibrium. One stake (719) shows a small erosional change of 0.5 cm. This is well within the allowed 2 cm change per year. All other stakes (705, 712, 713) show no change.

The sediment performance goal has been met. Adaptive management recommendations for sediment issues consist of continuing to monitor the site to ensure none of the capped areas experience a loss of sediment, which could expose underlying materials.

5.0 Maintenance / Adaptive Management

This section presents the maintenance activities that have been completed and the activities that are proposed under the adaptive management process.

5.1 Completed & On-going Activities

The installed irrigation system continues to operate during the dry months. Some adjustments in the irrigation schedule have been necessary to optimize performance. The amount of water each zone is receiving is evaluated and the sprinkling time is adjusted on an on-going basis. The current watering schedule is provided below in Table 4.

Table 4. Irrigation Schedule for Middle Waterway

Zone	Minutes of sprinkle	Start time	End time	Frequency
1	20	7:47 PM	8:07 PM	1x/48 hr
2	20	9:49 PM	10:09 PM	1x/48 hr
3	20	11:50 PM	12:10 AM	1x/48 hr
4	60	5:55 PM	6:55 PM	1x/24 hr
5	20	1:52 AM	2:12 AM	1x/48 hr
6	60	3:57 PM	4:57 PM	1x/24 hr

The Washington Conservation Corps (WCC) crew, sponsored by the City, visited the site twice during 2002 and performed routine maintenance and invasive species removal.

The City continues to contract with David Adams as the site steward. David frequently visits the site and maintains the goose exclusion devices (GED), removes noxious weeds as necessary, and gathers other pertinent information on the condition of the site. David also provides advice and expertise on adaptive management options.

Concurrent with plantings in the salt marsh areas, GED were constructed around the upper and lower salt marsh areas. In one area of the lower salt marsh, the chicken wire installed was extended vertically to discourage geese from browsing at high tide. As necessary, GED repairs are performed by David Adams.

5.2 Recommended Adaptive Management Activities

The overall health and vigor of the vegetation at this restoration site is very good. While one numerical performance goal was not met, it does not appear to be because of a lack of health of the plantings.

As discussed above, there are several non-native plant species that could crowd out the desirable species if they are not controlled. Therefore we intend to continue our weeding efforts targeting: white sweet clover, Canada thistle, St. John's wort, Himalayan blackberry, morning glory, Scot's broom, Tansy ragwort, and butterfly bush.

It is also recommended that the following activities continue:

- Monitor moisture in site soils during operation of irrigation system
- Monitor sedimentation and erosion
- Maintain GED
- Continue quantitative and qualitative monitoring efforts

Table 2
Quantitative Vegetation Monitoring Results

Transect:		Riparian 1 (11th Street ROW)				Riparian 2 (North of Substation)				Riparian 1 (11th Street ROW)				Riparian 2 (North of Substation)					
Quadrat #		R1-1	R1-2	R1-3	R1-4	R2-1	R2-2	R2-3	R2-4*	R1-1	R1-2	R1-3	R1-4	R2-1	R2-2	R2-3	R2-4	Avg Cover	Frequency
		Daubenmire Cover Class								Daubenmire Midpoints								%	%
Native Trees																			
Scientific name	*Common name*																		
Acer Macrophyllum	**Bigleaf maple**	0-5	0	0	0-5	0	0	0	0	2.5	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.6	25%
Alnus rubra	**Red alder**	0	15-25	0	0	5-15	5-15	5-15	0	0.0	20.5	0.0	0.0	12.5	12.5	12.5	0.0	7.3	50%
Arbutus menziesii	**Pacific madrone**	0-5	0	0-5	0	0	0	0	0	2.5	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.6	25%
Pinus contorta var. contorta	**Shore pine**	0	5-15	0	0-5	0-5	0-5	0	0-5	0.0	12.5	0.0	2.5	2.5	2.5	0.0	2.5	2.8	63%
unknown	Oak	0	0	0	0	0	0	0-5	0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.3	13%
Native Shrubs																			
Scientific name	*Common name*																		
Corylus cornuta var. californica	**Hazelnut**	0-5	0	0	0-5	0	0-5	0-5	0	2.5	0.0	0.0	2.5	0.0	2.5	2.5	0.0	1.3	50%
Holodiscus discolor	**Oceanspray**	0	0	0	0	0-5	0-5	0	0-5	0.0	0.0	0.0	0.0	2.5	2.5	0.0	2.5	0.9	38%
Rosa nutkana	**Nootka rose**	0-5	0-5	15-25	15-25	0-5	0-5	0-5	0	2.5	2.5	20.5	20.5	2.5	2.5	2.5	0.0	6.7	88%
Rubus parviflorus	Thimbleberry	0	0	0	0	0	0-5	0	0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.3	13%
Salix hookeriana	**Hooker's willow**	0	0-5	0	0	0-5	0-5	50-75	0-5	0.0	2.5	0.0	0.0	2.5	2.5	65.0	2.5	9.4	63%
Other Native Flora																			
Epilobium	Willowherb	0	0	0	0-5	15-25	25-50	5-15	25-50	0.0	0.0	0.0	2.5	20.5	35.0	12.5	35.0	13.2	63%
Equisetum arvense	Common horsetail	5-15	15-25	15-25	0	0-5	5-15	0-5	0	12.5	20.5	20.5	0.0	2.5	12.5	2.5	0.0	8.9	75%
Anaphalis margaritacea	Pearly everlasting	5-15	0-5	0-5	5-15	0-5	0-5	0	5-15	12.5	2.5	2.5	12.5	2.5	2.5	0.0	12.5	5.9	88%
Fragaria chiloensis	**Coastal strawberry**	0	0	0	0	0-5	0	0-5	0	0.0	0.0	0.0	0.0	2.5	0.0	2.5	0.0	0.6	25%
Total Native Vegetative Cover										35.0	61.0	46.0	43.0	50.5	77.5	102.5	55.0	58.8	
Non-native species																			
Scientific name	*Common name*																		
Rubus discolor	Himalyan blackberry	0-5	0-5	0-5	0-5	0	0	0	0-5	2.5	2.5	2.5	2.5	0.0	0.0	0.0	2.5	1.6	
Cytisus scoparius	Scot's broom	0	0	0	0	0-5	0	0	0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.3	
Leucanthemum vulgare	Oxeye daisy	0	0	0	0	0	0-5	0	0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.3	
Cirsium arvense	Canada thistle	0-5	0	0	0	0-5	0-5	0-5	0-5	2.5	0.0	0.0	0.0	2.5	2.5	2.5	2.5	1.6	
Hypericum perforatum	St. John's Wort	0-5	0	0-5	0	0	0-5	0-5	0-5	2.5	0.0	2.5	0.0	0.0	2.5	2.5	2.5	1.6	
	Butterfly bush	25-50	5-15	15-25	15-25	0-5	0-5	0-5	0-5	35.0	12.5	20.5	20.5	2.5	2.5	2.5	2.5	12.3	
	Grass	50-75	50-75	50-75	25-50	0	5-15	0-5	0-5	65.0	65.0	65.0	35.0	0.0	12.5	2.5	2.5	30.9	
Linaria dalmatica	Dalmation toadflax	0	0	0	5-15	0	0	0	0	0.0	0.0	0.0	12.5	0.0	0.0	0.0	0.0	1.6	
Plantago lanceolata	English plaintain	0-5	0-5	0-5	5-15	0-5	0-5	0	0-5	2.5	2.5	2.5	12.5	2.5	2.5	0.0	2.5	3.4	
Melilotus alba	White sweet clover	15-25	25-50	15-25	5-15	0	0	0-5	0-5	20.5	35.0	20.5	12.5	0.0	0.0	2.5	2.5	11.7	
Ranunculus repens	Buttercup	5-15	0-5	0-5	0-5	0	0-5	0-5	0-5	12.5	2.5	2.5	2.5	0.0	2.5	2.5	2.5	3.4	
Convolvulus arvensis	Morning glory	0	0-5	0	0-5	0	0	0-5	0	0.0	2.5	0.0	2.5	0.0	0.0	2.5	0.0	0.9	
Senecio jacobaea	Tansy ragwort	0	0	0	0	0-5	0	0	0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.3	
	Unknown[1]	0	0	0	0	0-5	0-5	0	0	0.0	0.0	0.0	0.0	2.5	2.5	0.0	0.0	0.6	
Taraxacum offinitale	Common dandelion	0	0-5	0-5	0-5	0	0	0-5	0	0.0	2.5	2.5	2.5	0.0	0.0	2.5	0.0	1.3	
Matricaria discoidea	Pineapple weed	0	0	0	0-5	0	0	0	0-5	0.0	0.0	0.0	2.5	0.0	0.0	0.0	2.5	0.6	
Conyza canadensis var. glabrata	Canadian fleabane	0	0	0	0	0-5	0	0	0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.3	
Gnaphalium microcephalum	Slender cudweed	0	0	0	0	0	0-5	0	0-5	0.0	0.0	0.0	0.0	0.0	2.5	0.0	2.5	0.6	
Total Vegetative Cover										178.0	186.0	164.5	148.5	68.0	110.0	122.5	80.0	132.2	
Other																			
Bare substrate		0	5-15	15-25	5-15	25-50	0	0-5	15-25	0.0	12.5	20.5	12.5	35.0	0.0	2.5	20.5	12.9	

* Storage box for NWFSC sampling equipment located in this quadrat (approximate size 4.5' x 2.25')

[1]Similar looking to madrone

Bold - Indicates plants that were planted as per the planting plan on November 4, 2000

Underline - Indicates plants that are on the Pierce County or Washington State Noxious weed list

Table 2 Continued
Quantitative Vegetation Monitoring Results

Transect:		Upper Salt Marsh Transect																				
Quadrat #		U-1	U-2	U-3	U-4	U-5	U-6	U-7	U-8	U-9	U-10		U-1	U-2	U-3	U-4	U-5	U-6	U-7	U-8	U-9	U-10	Avg Cover
		Daubenmire Cover Class											Daubenmire Midpoints										%
Native Species																							
Scientific name	*Common name*																						
Deschampsia cespitosa ssp. beringensis	**Tufted hairgrass**	0	0	0-5	25-50	0	25-50	0	0	50-75	0		0.0	0.0	2.5	35.0	0.0	35.0	0.0	0.0	65.0	0.0	13.8
Distichlis spicata var. spicata	**Seashore saltgrass**	0	5-15	5-15	0	0	0	0	25-50	0-5	5-15		0.0	12.5	12.5	0.0	0.0	0.0	0.0	35.0	2.5	12.5	7.5
Equisetum arvense	Common horsetail	0	0	0	0	0	0	0	0	0	0-5		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.3
Anaphalis margaritacea	Pearly everlasting	0	0	0	0	0	0	0	25-50	0	0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.0	0.0	0.0	3.5
Total Native Vegetative cover													0.0	12.5	15.0	35.0	0.0	35.0	0.0	70.0	67.5	15.0	25.0
Non-native species																							
Scientific name	*Common name*																						
Cirsium arvense	Canada Thistle	0	0	0	0	0	0	0	0	0	0-5		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.3
Epilobium angustifolium	Fireweed	0	0	0	0	0	0	0	5-15	0	0-5		0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.5	0.0	2.5	1.5
Melilotus alba	White Sweet clover	25-50	15-25	15-25	0-5	5-15	15-25	0	5-15	5-15	50-75		35.0	20.5	20.5	2.5	12.5	20.5	0.0	12.5	12.5	65.0	20.2
Plantago lanceolata	English plantain	0	0	5-15	0	0	0-5	0	5-15	0-5	0-5		0.0	0.0	12.5	0.0	0.0	2.5	0.0	12.5	2.5	2.5	3.3
Matricaria discoidea	Pineapple weed	0-5	0	0	0	0-5	0	0	5-15	0	0		2.5	0.0	0.0	0.0	2.5	0.0	0.0	12.5	0.0	0.0	1.8
	Grass	0	5-15	0	0	0	0	0	0	0	0		0.0	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3
Chenopodium album	Lamb's quarters	0	0	0	0	0-5	0	0	0	0	0		0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.3
	Moss	0	75-95	0	25-50	0	0	0	0	0	0		0.0	85.0	0.0	35.0	0.0	0.0	0.0	0.0	0.0	0.0	12.0
Polygonum persicaria	Lady's thumb	0	0	0	0	0	0	0	0	0	5-15		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.5	1.3
Total Vegetative cover													37.5	130.5	48.0	72.5	17.5	58.0	0.0	120.0	82.5	100.0	66.7
Other																							
Bare substrate		50-75	0-5	0	25-50	95-100	50-75	95-100	0	15-25	15-25		65.0	2.5	0.0	35.0	97.5	65.0	97.5	0.0	20.5	20.5	40.4

Bold - Indicates plants that were planted as per the planting plan on May 26, 2001

Underline - Indicates plants that are on the Pierce County or Washington State Noxious weed list

Table 2 Continued
Quantitative Vegetation Monitoring Results

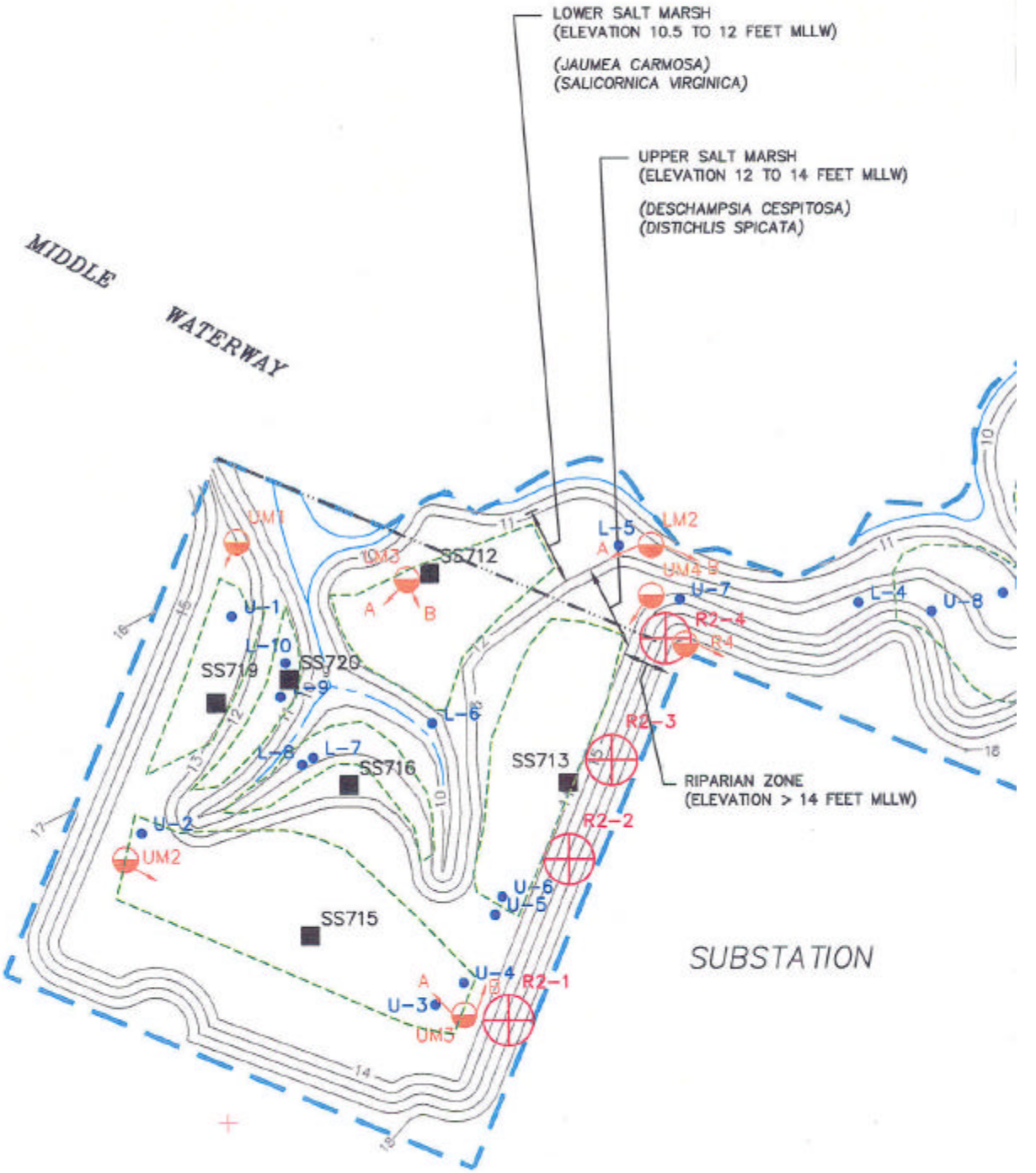
Transect:		Lower Salt Marsh Transect																				
Quadrat #		L-1	L-2	L-3	L-4	L-5	L-6	L-7	L-8	L-9	L-10		L-1	L-2	L-3	L-4	L-5	L-6	L-7	L-8	L-9	L-10	Avg Cover
		Daubenmire Cover Class											Daubenmire Midpoints										%
Native Species																							
Scientific name	*Common name*																						
Jaumea carnosa	**Fleshy jaumea**	0	0	0	0	0	0	0	0	0	0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Salicornia virginica	**Pickleweed**	15-25	5-15	0-5	0	0	0	0	5-15	5-15	15-25		20.5	12.5	2.5	0.0	0.0	0.0	0.0	12.5	12.5	20.5	8.1
Total Native Vegetative cover													20.5	12.5	2.5	0.0	0.0	0.0	0.0	12.5	12.5	20.5	8.1
Invasive species																							
Scientific name	*Common name*																						
Spergularia	Spurry	0-5	5-15	0	0	0	0	0	0	0	0		2.5	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
Total Vegetative cover													23.0	25.0	2.5	0.0	0.0	0.0	0.0	12.5	12.5	20.5	9.6
Other																							
Bare substrate		50-75	75-95	95-100	95-100	95-100	95-100	95-100	75-95	75-95	75-95		65.0	85.0	97.5	97.5	97.5	97.5	97.5	85.0	85.0	85.0	89.3

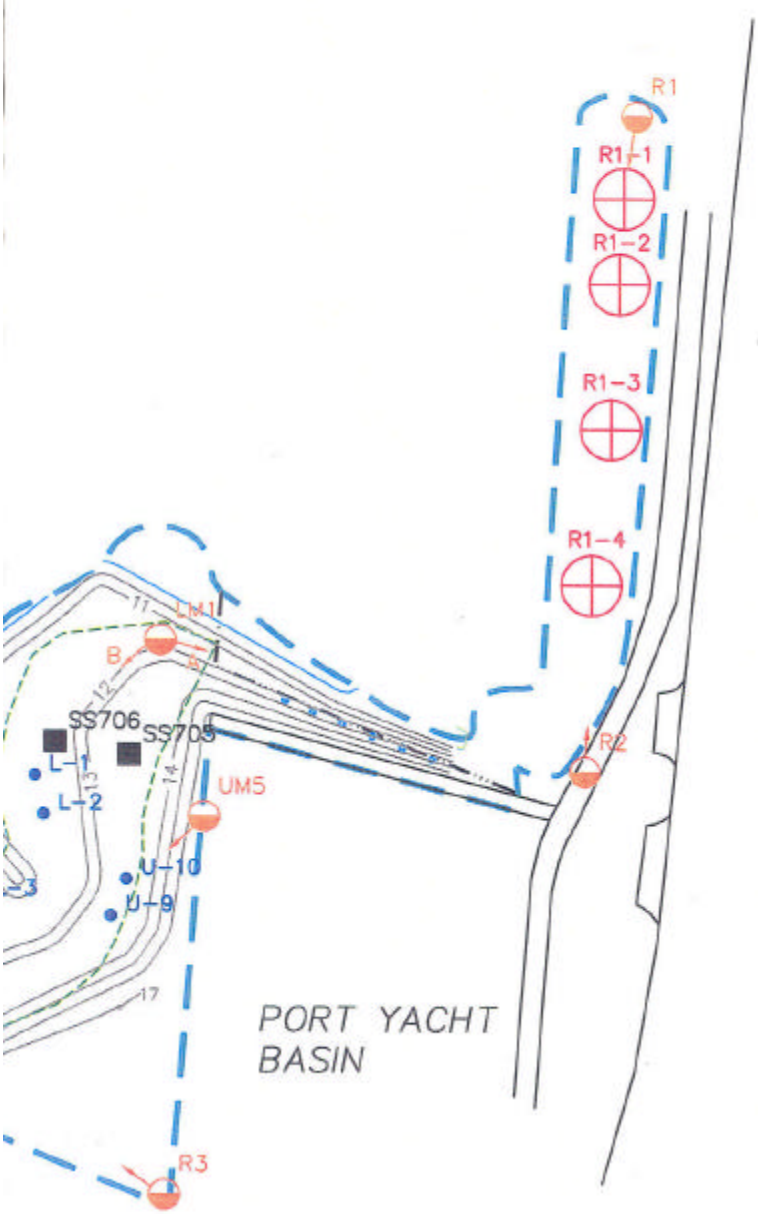
Bold - Indicates plants that were planted as per the planting plan on May 26, 2001

Appendix A

Photo Point Pictures

FIGURE 1


LOWER SALT MARSH
(ELEVATION 10.5 TO 12 FEET MLLW)
(JAUMEA CARMOSA)
(SALICORNICA VIRGINICA)
UPPER SALT MARSH
(ELEVATION 12 TO 14 FEET MLLW)
(DESCHAMPSIA CESPITOSA)
(DISTICHLIS SPICATA)
MIDDLE WATERWAY
RIPARIAN ZONE
(ELEVATION > 14 FEET MLLW)
SUBSTATION
UM1
UM3
SS712
LM2
L-5
UM4
U-7
L-4
U-8
U-1
L-10
SS719
SS720
L-9
L-6
L-8
L-7
SS716
SS713
R2-3
R2-4
R4
R2-2
U-2
UM2
U-6
U-5
SS715
U-4
R2-1
U-3
UM5



LEGEND

- RIPARIAN QUADRANTS 28.3 m
- SALT MARSH QUADRANTS 0.25 m
- SEDIMENT STAKES
- PHOTO POINTS
- SALT MARSH PLANTED AREAS WITH GOOSE EXCLUDER
- PROJECT BOUNDARY

N

0 30 60
Scale in Feet

CITY OF TACOMA
DEPARTMENT OF PUBLIC WORKS

MIDDLE WATERWAY
RESTORATION PROJECT

DATE 10-12-01		SCALE 1"=30'
DES JOL	MANAGER ENGINEERING DIVISION	
DR REG	CITY ENGINEER	SHEET 1 OF 1
CK JGP	DIRECTOR OF PUBLIC WORKS	YEAR-0.DWG

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: R1

Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: R1

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: R1

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: R1

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: R2

Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: R2

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: R2

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: R2

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: R3

Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: R3

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: R3

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: R3

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: R4

Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: R4

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: R4

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: R4

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: UM1

Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: UM1

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: UM1

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: UM1

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: UM2

Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: UM2

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: UM2

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: UM2

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: UM3A

Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: UM3A

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: UM3A

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: UM3A

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: UM3B

Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: UM3B

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: UM3B

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: UM3B

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: UM4

Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: UM4

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: UM4

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: UM4

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: UM5

Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: UM5

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: UM5

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: UM5

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: LM1A

Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: LM1A

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: LM1A

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: LM1A

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: LM1B

Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: LM1B

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: LM1B

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: LM1B

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: LM2A

Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: LM2A

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: LM2A

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: LM2A

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: LM2B

Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: LM2B

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: LM2B

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: LM2B

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: LM3A

Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: LM3A

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: LM3A

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: LM3A

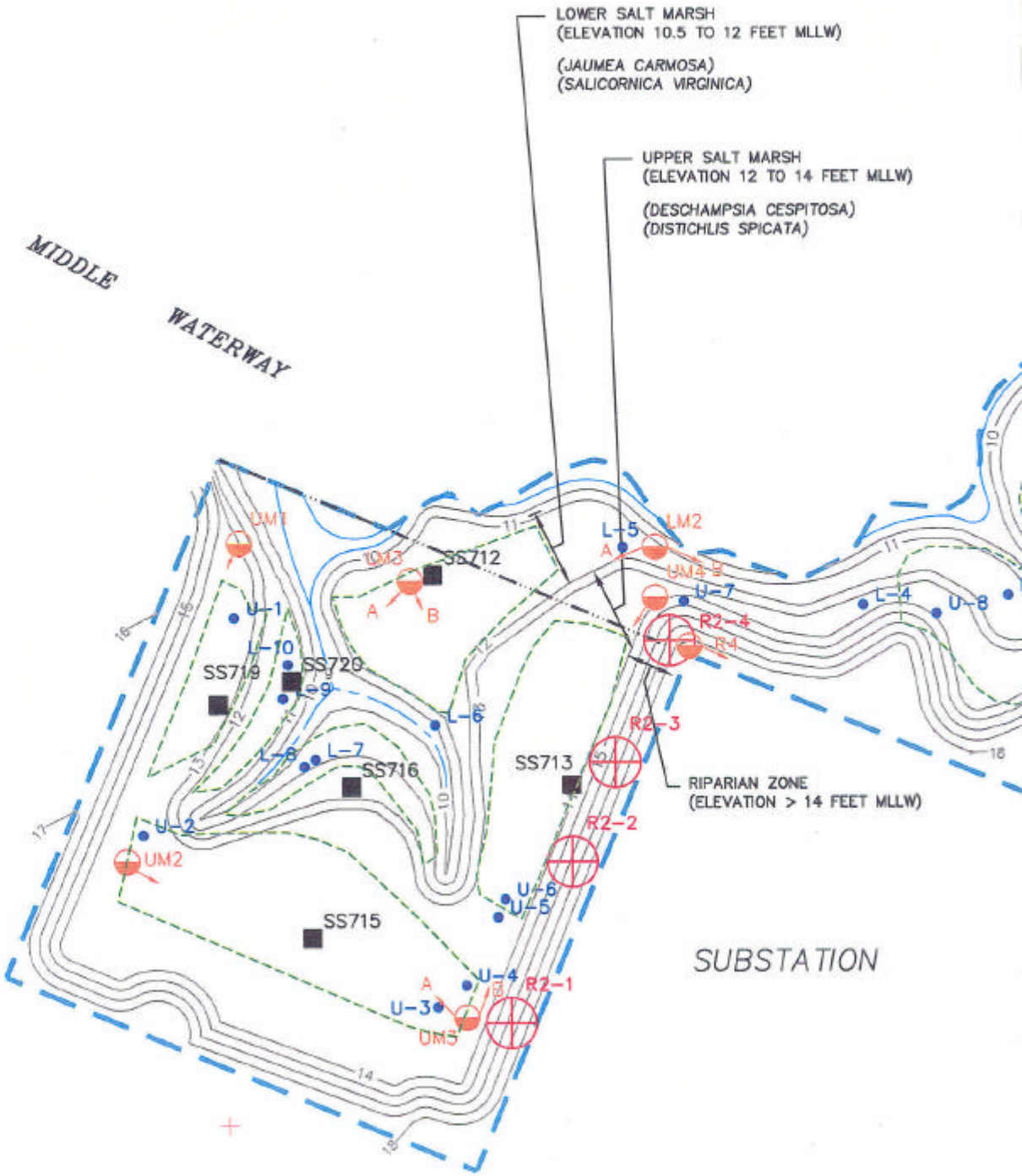
Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: LM3B

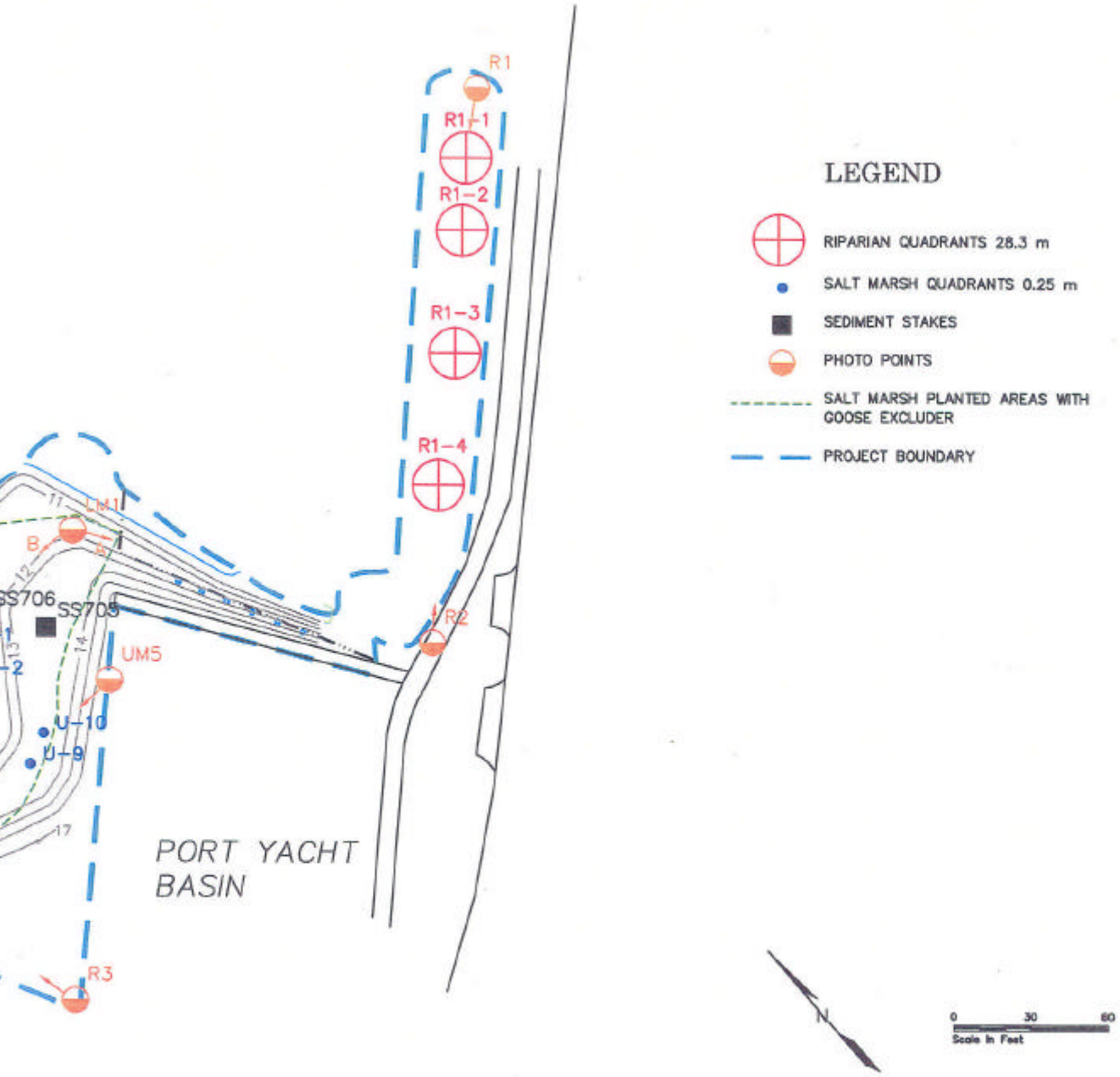
Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: LM3B

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: LM3B

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: LM3B

FIGURE 1


LOWER SALT MARSH
(ELEVATION 10.5 TO 12 FEET MLLW)
(JAUMEA CARMOSA)
(SALICORNICA VIRGINICA)
UPPER SALT MARSH
(ELEVATION 12 TO 14 FEET MLLW)
(DESCHAMPSIA CESPITOSA)
(DISTICHLIS SPICATA)
MIDDLE WATERWAY
UM1
UM3
SS712
LM2
L-5
UM4
U-7
L-4
U-8
U-1
L-10
SS719
SS720
L-9
L-6
R2-4
R4
R2-3
L-8
L-7
SS716
SS713
RIPARIAN ZONE
(ELEVATION > 14 FEET MLLW)
U-2
UM2
R2-2
U-6
U-5
SS715
SUBSTATION
U-4
R2-1
U-3
UM5



CITY OF TACOMA
DEPARTMENT OF PUBLIC WORKS

MIDDLE WATERWAY RESTORATION PROJECT

DATE 10-12-01		SCALE 1"=30'
DES JOL	MANAGER ENGINEERING DIVISION	
DR REG	CITY ENGINEER	SHEET 1 OF 1
CK JGP	DIRECTOR OF PUBLIC WORKS	YEAR-0.DWG DWG NAME

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: R1

Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: R1

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: R1

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: R1

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: R2

Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: R2

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: R2

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: R2

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: R3

Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: R3

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: R3

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: R3

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: R4

Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: R4

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: R4

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: R4

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: UM1

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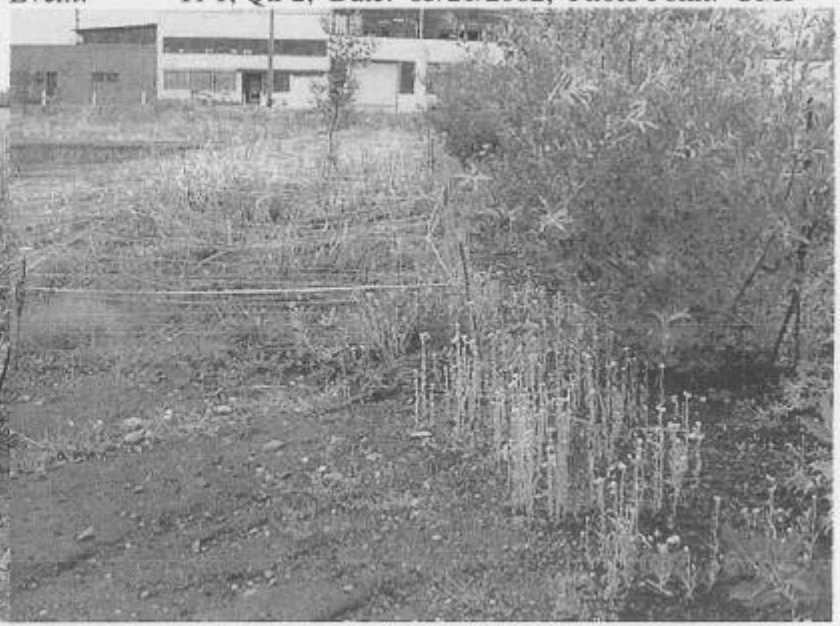
Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: UM1



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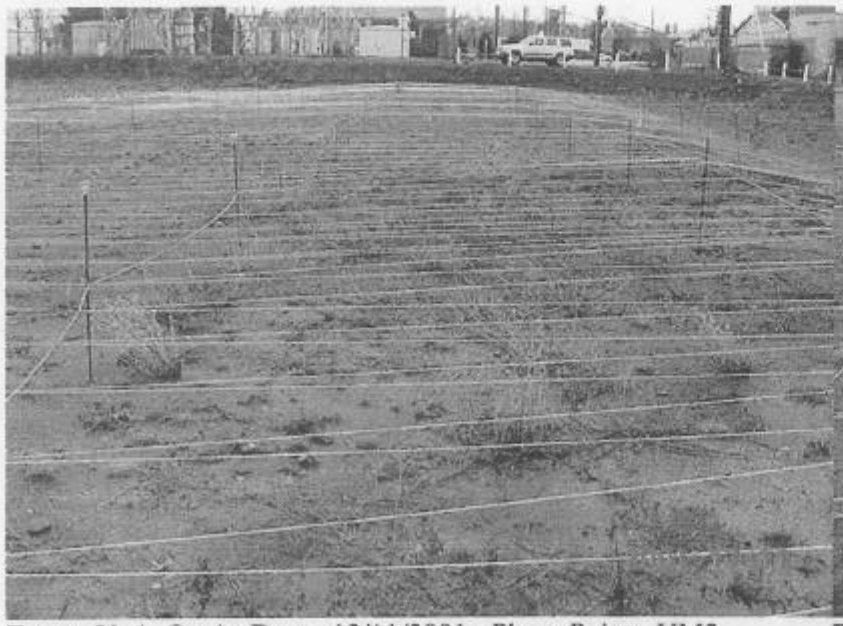

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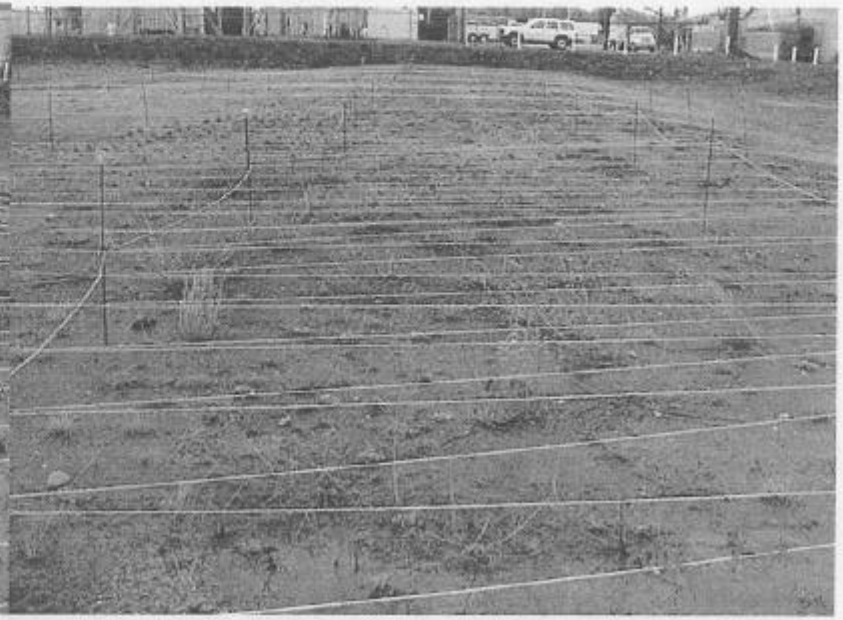

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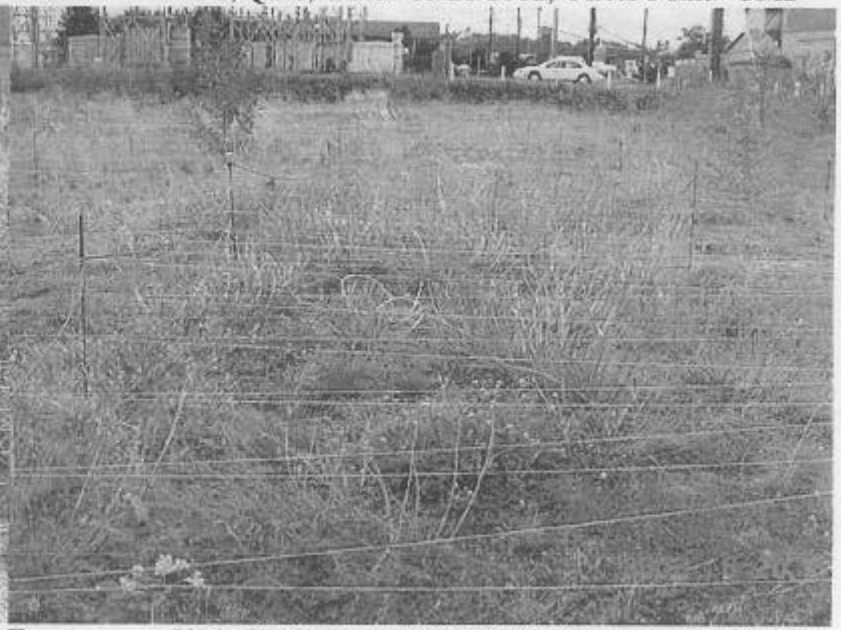

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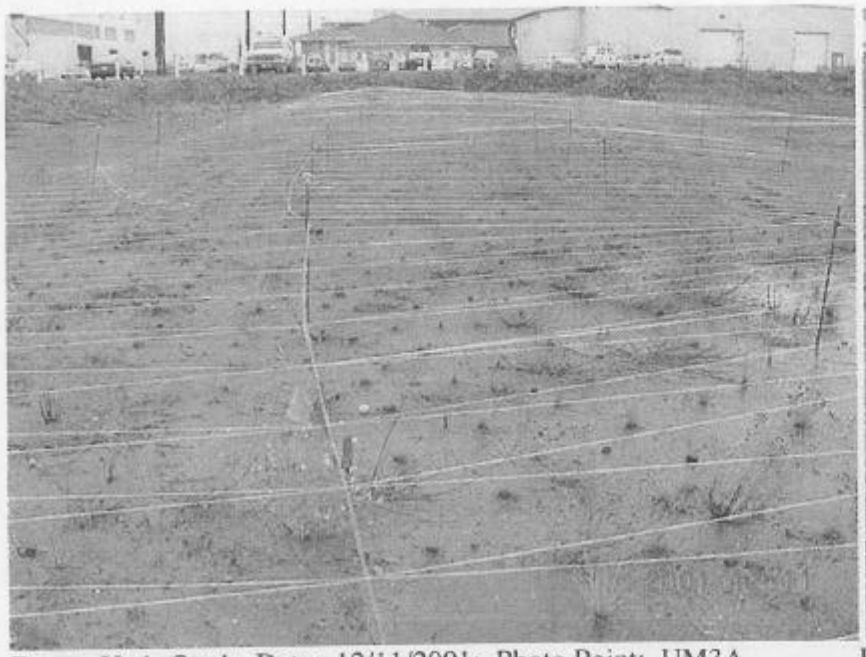

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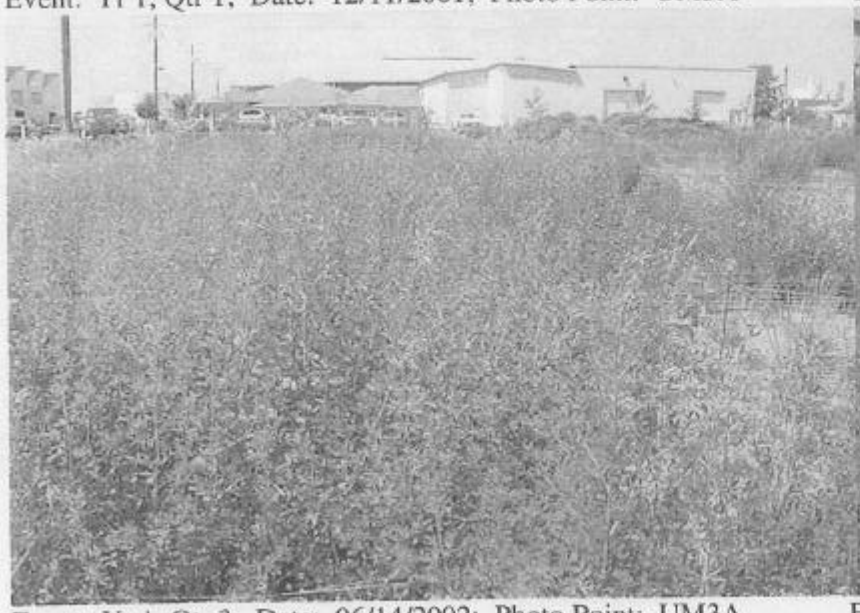

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Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: UM3B

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: UM3B

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: UM3B

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: UM4

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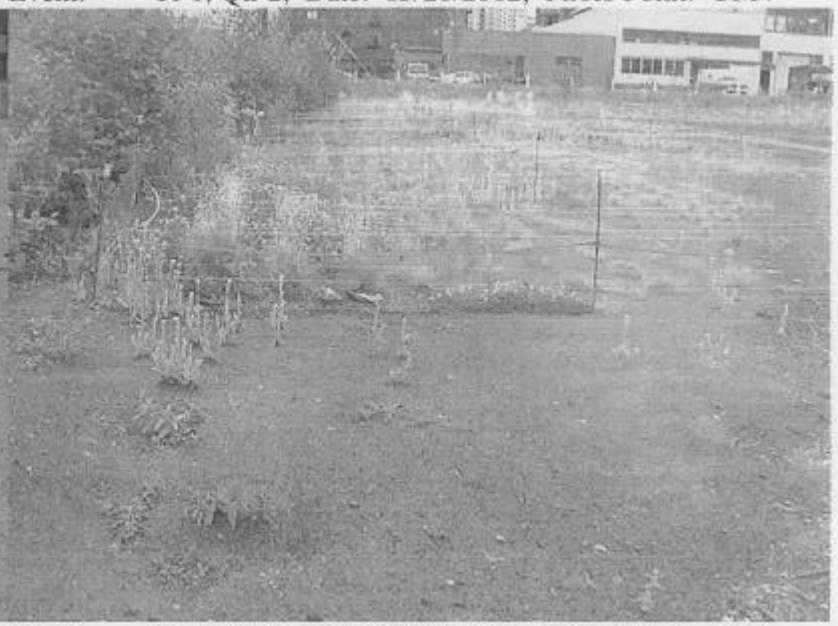
Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: UM4



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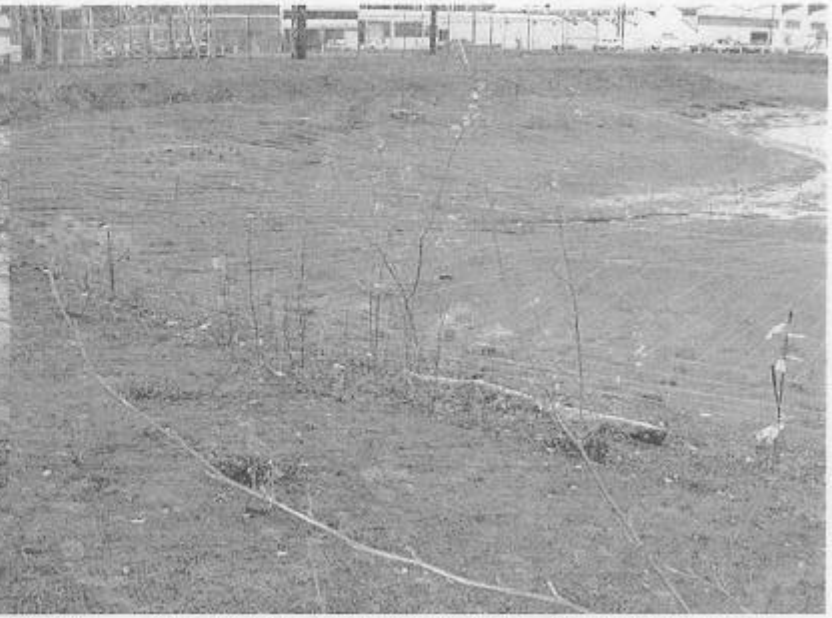
Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: UM5

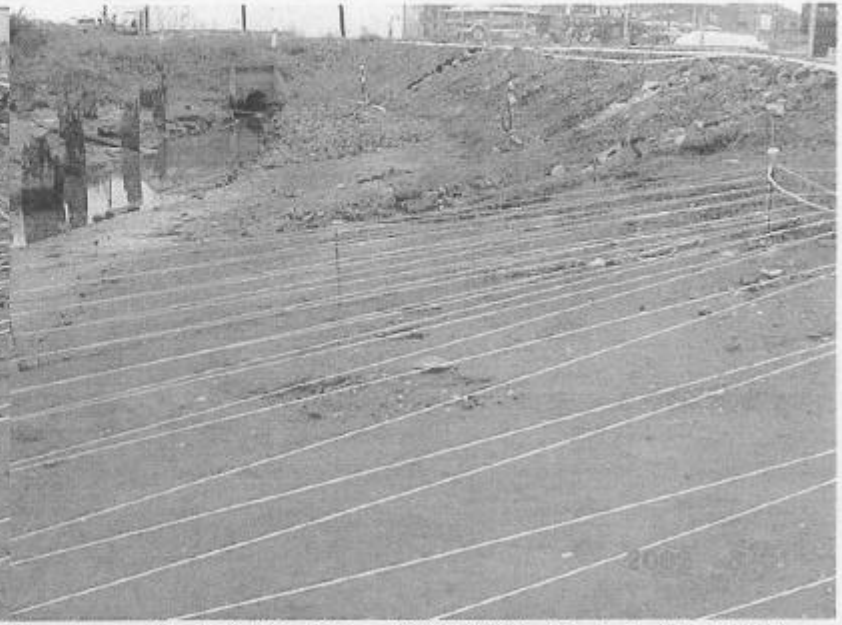


Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: UM5

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: UM5

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: UM5

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: LM1A



Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: LM1A

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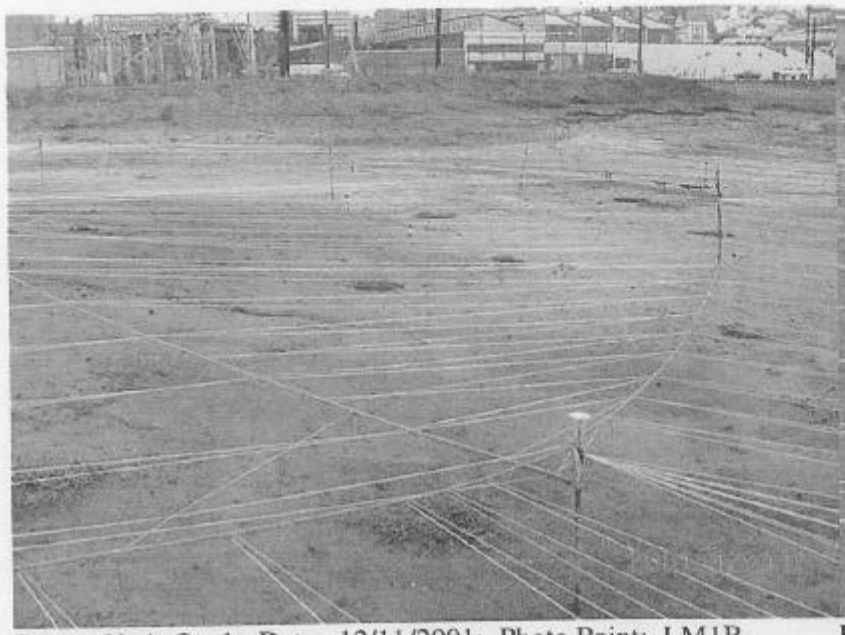
Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: LM1A



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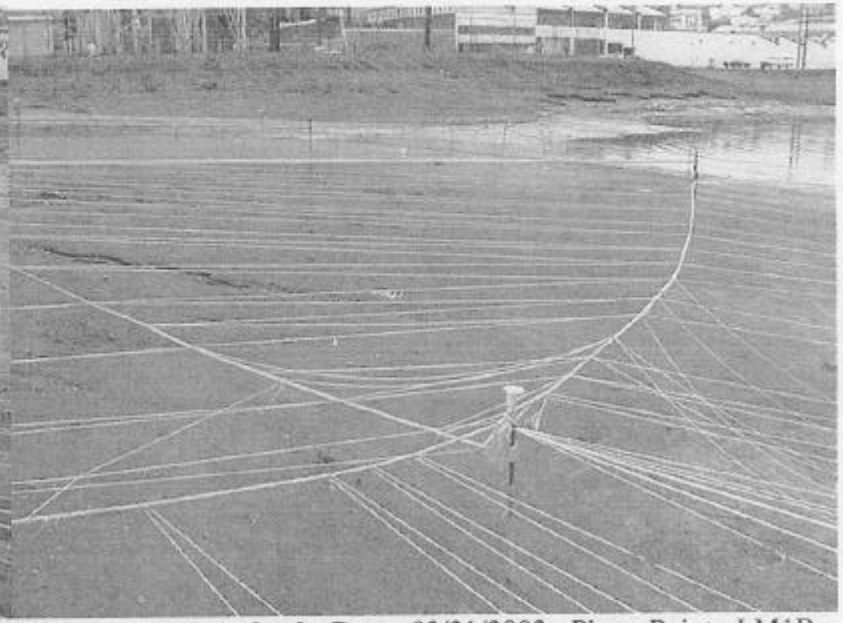
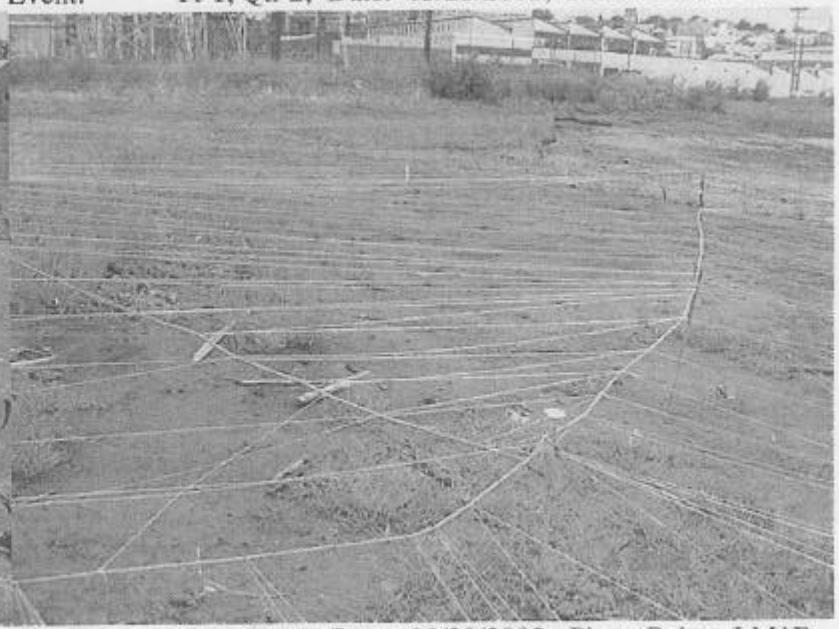


Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: LM1B

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: LM1B



Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: LM1B

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: LM2A

Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: LM2A

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: LM2A

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: LM2A

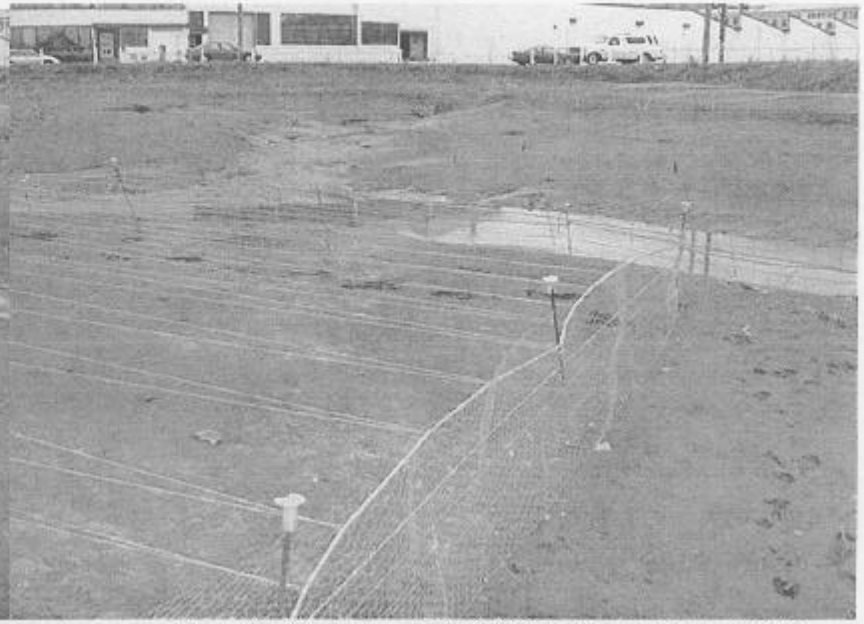
Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: LM2B

Event: Yr 1, Qtr 2; Date: 03/21/2002; Photo Point: LM2B

Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: LM2B

Event: Yr 1, Qtr 4; Date: 08/20/2002; Photo Point: LM2B

Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: LM3A



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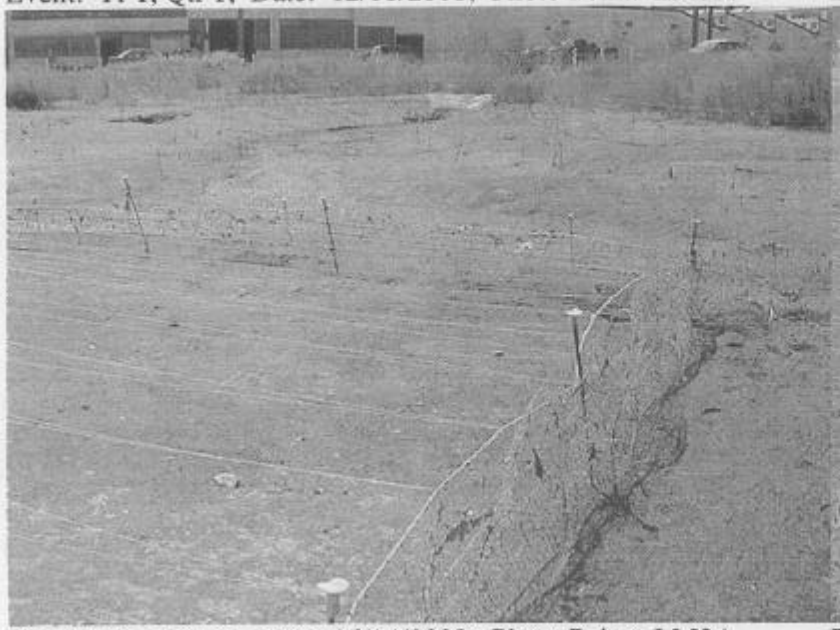

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Event: Yr 1, Qtr 1; Date: 12/11/2001; Photo Point: LM3B

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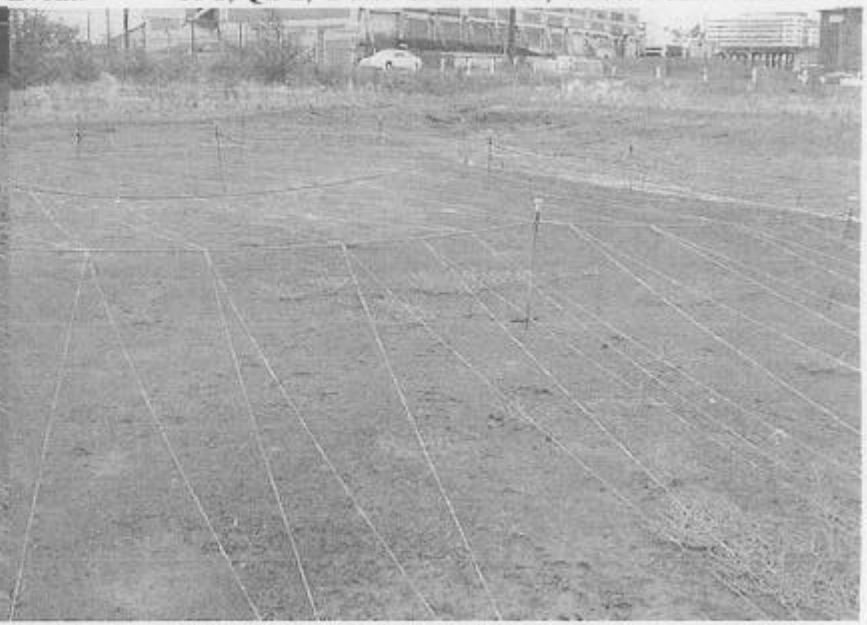
Event: Yr 1, Qtr 3; Date: 06/14/2002; Photo Point: LM3B



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