SECTION 5. RECOMMENDED PLAN

5.1 Description of the Recommended Plan. The proposed project will consist of three main components: (1)creation of wetland benches and a meandering channel by dredging the Columbia Slough between MCDD Pump Station No. 1 (MCDD #1) and NE 158th Avenue to a designed depth, then placing the material along opposite sides of the channel to create wetland benches; (2) replacing three culverts in Buffalo Slough and two culverts in Whitaker Slough; and (3) constructing a wetland marsh covering nine acres at Galitzski Flats near 162nd Avenue, and restoring nine acres of adjacent riparian woodland habitat at Galitzski Springs by removing invasive species and planting native species.

5.2 Design Features

5.2.1 Wetland Benches. The wetland benches will be planted to provide emergent wetland and riparian scrub-shrub wetland vegetation, depending on actual water depth. In addition to wetland creation, channel bank vegetation would be restored by removing Himalayan blackberry and other non-native plants that inhibit native vegetation and then planting riparian trees and shrubs.

The assessment area (Figures 3a and 3b) includes the main Columbia Slough from NE 158th Avenue downstream 7.6 miles to the levee at the Peninsula Drainage Canal at NE 17th Avenue (MCDD Pump Station #1). Although the slough extends upstream of NE 158th Avenue to Fairview Lake, the proposed action would not affect this reach.

The ecological goal for constructing wetland benches in Columbia Slough is to increase channel habitat complexity while providing a hydrologic period that more closely mimics off-channel sloughs with direct connection to the Columbia River. Ecosystem restoration criteria include restoring riparian scrub-shrub, emergent wetland and aquatic bottom habitat to optimal condition for yellow warbler and benthic invertebrates.

The proposed action would create or enhance three habitat types: riparian scrub-shrub, emergent wetland, and aquatic bottom. These habitat types correspond with Cowardin's classification of palustrine systems (Cowardin et al. 1979). In the main Columbia Slough, riparian scrub-shrub occurs above the summer low water elevation, which is 5.5 feet in the middle slough and 8.5 feet in the upper slough. Emergent wetland occurs in the zone between riparian scrub-shrub and approximately 3 feet below the mean summer water elevation. Aquatic bottom habitat is permanently flooded and occurs more than 3 feet below the low summer water elevation, which is generally the maximum depth at which emergent plants can grow. Additional aquatic bottom habitat is created by this alternative when the dredging increases the channel bottom area where water depths exceed 3 feet during the summer low water elevation.

An estimated total of 44,900 cubic yards of material would be excavated from the channel bottom and placed within the channel. There would be three segments where the wetland benches would be created.

- *MCDD Pump Station (PS) #1 to the mouth of Whitaker Slough:* This reach, extending about 1.3 miles, would have 13,050 cubic yards of material dredged from the channel bottom. Columbia Slough is relatively wide in this segment, with channel bottom widths of 60 – 80 feet. Material would be dredged in two passes near each side of the channel, with the dredged material placed in the center of the channel to create an island (Figure 6). After planting with the appropriate vegetation, this would create 1.4 acres of emergent wetland and 1.0 acre of riparian scrub-shrub habitat. Deepening the channel will also result in an increase of 0.6 acres of aquatic bottom habitat.
- *Mouth of Whitaker Slough to mid-dike levee:* This reach, extending about 5.4 miles, would have 26,250 cubic yards of material dredged from the channel bottom and placed on alternating sides of the channel (Figure 7). The channel bottom is typically 20 – 45 feet wide in the reach, and channel banks are typically steep and covered with Himalayan blackberry. After planting, about 8.3 acres of emergent wetland and 1.0 acre of additional aquatic bottom habitat would be created.
- *Mid-dike levee to NE 158th Avenue:* This reach, extending about 0.8 miles, would have 5,600 cubic yards of material dredged from the channel bottom and placed on alternating sides of the channel. Channel bottom widths vary between 18 – 62 feet. After planting, about 1.6 acres of emergent wetland and 0.1 acre of additional aquatic bottom habitat will be created.

Immediately upstream of the last reach, bedrock is near the channel bottom until the "Four Corners" segment is reached, where an arm of Columbia Slough branches off to MCDD Pump Station #4 next to the main flood control levee. There are preservation and conservation zones, as well as wetland mitigation areas, upstream of the Four Corners area to the outlet of Fairview Lake. Creation of additional wetland benches is not warranted in this reach.

5.2.1.1 Water Level Management. Water levels in Columbia Slough are managed with a system of levees, dikes, slide gates and pumps. Key issues for development and maintenance of wetland vegetation in the slough include seasonal water depth and the timing, duration and frequency of drawdowns. The speed of drawdowns strongly effects the kinds and variety of vegetation cover that an area will support. A slow drawdown taking 4 to 6 weeks to complete usually produces a more diverse vegetative cover than a fast drawdown taking only a few days. Timing of drawdown also effects vegetation diversity. Maintaining high water levels (>18") through June has been shown to suppress reed canary grass.

Currently, normal pool elevation in Columbia Slough is maintained at 5.5 feet in the middle slough and 8.0 feet in the upper slough throughout the year. The higher water elevations in the upper slough are necessary for irrigation and wetland maintenance. Although water elevations usually rise during heavy storm events, pumping returns water elevations to normal pool within 3 days. Water levels in the middle slough can be allowed to drop below 5.5 feet but only when the Columbia River falls below elevation 4.5 feet.

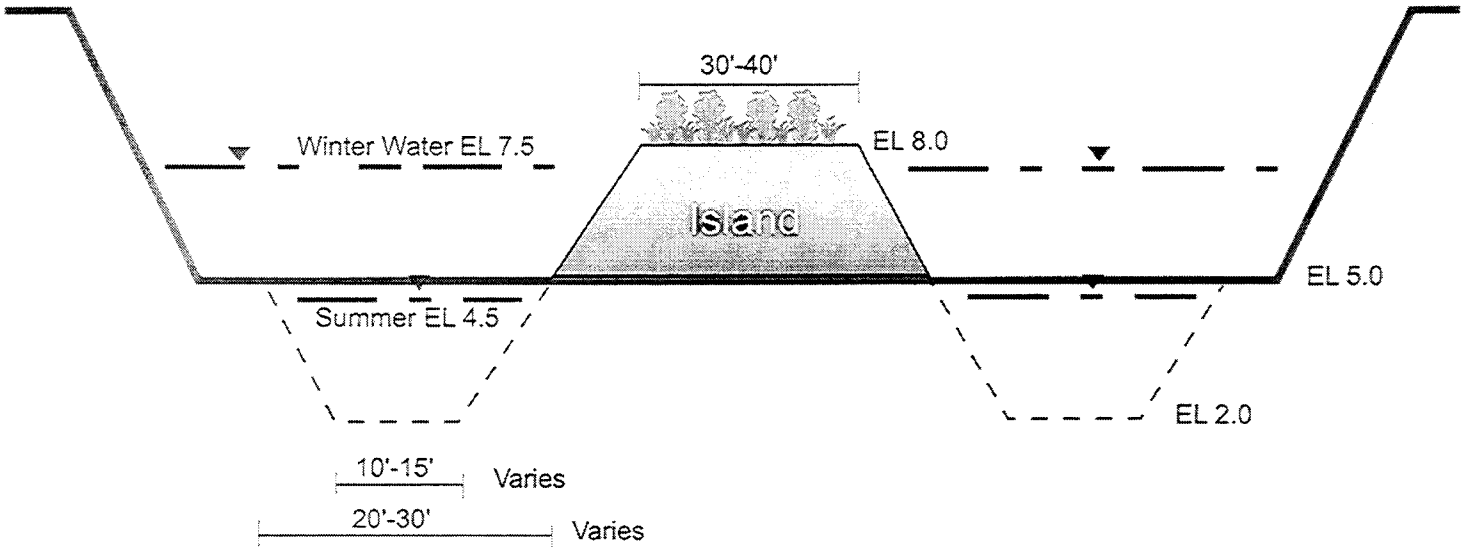

Figure 6. Middle Slough Island Design & Trench

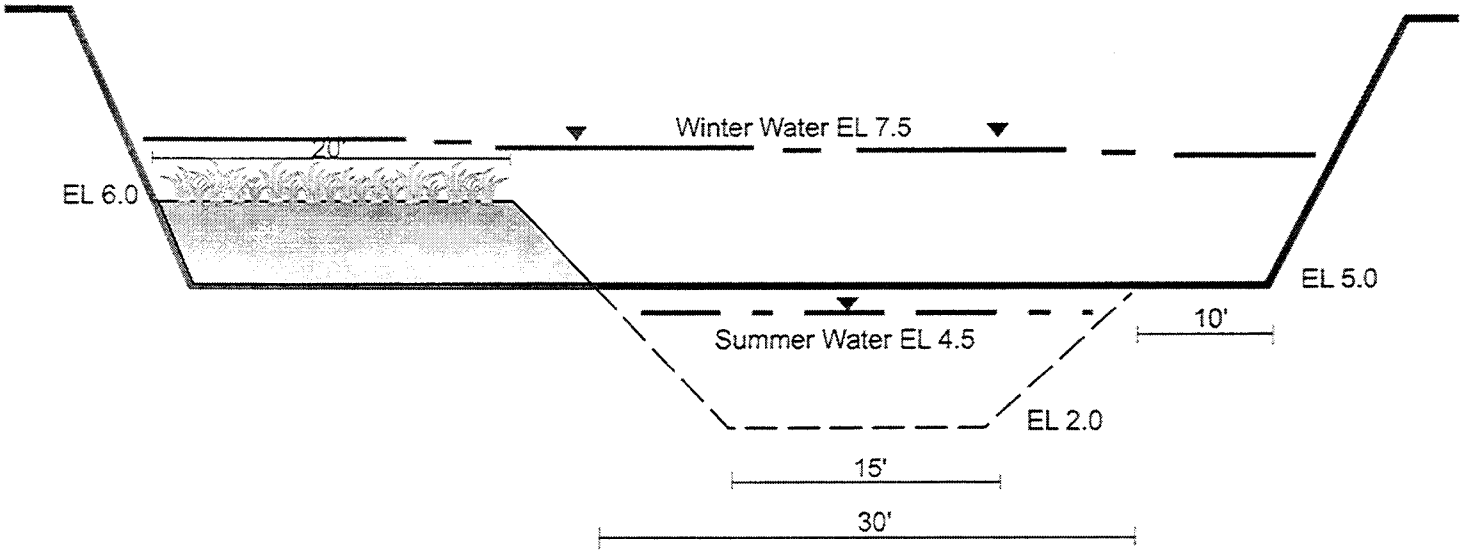

Figure 7. Middle Slough Bench & Trench Design

Not to Scale

Table 5.1. Number of acres HUs, and design water elevations for wetland benches.

REACH Habitat Type	DESIGN ELEV.'	ACRES		NEW HUs
		Existing	With project	
PS#1 TO WHITAKER SLOUGH				
Riparian scrub-shrub	5.0-6.5	0.0	1.0	1.0
Emergent wetland	2.0-5.0	0.0	1.4	1.4
Aquatic bottom*	<2.0	8.1	5.5	0.6
Total		8.1	7.9	3.0
WHITAKER SLOUGH TO MID-DIKE				
Riparian scrub-shrub	5.5-7.0	0.0	0.0	0.0
Emergent wetland	2.5-5.5	2.2	9.1	8.3
Aquatic bottom*	<2.5	20.6	15.1	1.0
Total		22.8	24.2	9.3
MID-DIKE TO 158th Avenue				
Riparian scrub-shrub	8.5-10	0.0	0.0	0.0
Emergent wetland	5.5-8.5	1.6	2.2	1.6
Aquatic bottom*	<5.5	2.8	2.2	0.1
Total		4.4	4.4	1.7
PS#1 TO 158th Avenue				
Riparian scrub-shrub		0.0	1.0	1.0
Emergent wetland		3.8	12.7	11.3
Aquatic bottom*		31.5	22.8	1.7
Total		**35.3**	**36.5**	**14.0**

* Increase in aquatic bottom habitat is due to increase in area where water depths exceed 3 feet.

Minimum pool elevations throughout the year provide very little opportunity to mimic the gradual drawdown of off-channel sloughs that typically would occur if the slough had a direct connection to the Columbia River. Ideally, drawdown would commence in late-May or early-June and take a minimum of 4 weeks to complete. This regime would provide more diverse riparian vegetation than a rapid drawdown. One alternative to current management would be to hold water levels above mean pool elevation in late-winter through early-spring, begin slowly drawing down in May, and attain minimum pool by about mid-June. Drawdown would be delayed to late-June in some years to suppress reed canary grass. This scenario may have short-term negative effects to certain water quality parameters but these impacts may be offset by improved development of wetland vegetation.

5.2.1.2 Vegetation Plantings. Winter water levels are less of a concern for riparian plant development than are summer levels. Emergent plants are particularly sensitive to water depth. Even short-term flooding of 2 to 3 feet will severely limit emergent plant

distribution. Emergent vegetation cannot survive even short-term exposure. As long as the ideal water depth for marsh emergents (1-2 feet) is continually shifting within an impoundment, their success will be limited. Predicting water levels in the slough to within inches is problematic due to the effects of macrophytes on flow. It is recommended that water levels be measured at the wetland benches before planting any species of emergent vegetation that are highly sensitive to fluctuating water levels. The benches should be seeded with native graminoids at the predicted summer low water level to control soil erosion.

Riparian shrubs should dominate wetland bench vegetation at elevations above the mean low water level. Habitat for yellow warbler includes a dense (>70%) deciduous shrub canopy with average height ≥6.5 feet. Shading exceeding 80% has been shown to suppress reed canary grass biomass. Riparian shrubs such as willows, spiraea, and red-osier dogwood are hydrophytic shrubs, which can withstand flooding and perform well in environments with fluctuating water levels. The benches should be densely planted with shrub seedlings to accelerate establishment of a robust riparian zone that will control reed canary grass. Drawdown should begin no later than mid-July to provide an adequate growing period for native shrub vegetation.

5.2.2 Buffalo Slough and Whitaker Slough Culverts

Various modeling runs conducted for the Whitaker Slough (Berger and Wells, 1997, 1999) indicate that west of the NE 78th Court no changes in the channel bottom but only changes in culvert invert elevation are required to achieve improved water quality.

Culvert invert elevations and diameter were selected using the following criteria:

- Invert elevation to be a minimum of ½ foot below the minimum summer low flow elevation. This will provide sufficient capacity to prevent water backup upstream of the culvert.
- The top of the culvert would be above the maximum summer water elevation. This will allow free passage of floating organic material (algae, duckweed) and debris.

Assuming a minimum summer low flow water level elevation of about 4.5 feet along Buffalo Slough and about 5 feet in Whitaker Slough near NE 78th Court, the maximum invert elevation would be about 4.5 feet at the east end of the study area and about 4 feet at the west end (Table 5.2). These assumptions are based on long-term observations of water levels in the Willamette River and limitations of the pumps at the MCDD#1. Most likely, the summer low flow water level elevations will be higher for the following reasons:

- Hydrophytic vegetation on wetland benches and berms in the main Slough will require regular inundation or saturation for some time during the growing season.
- Macrophyte growth in the low flow channel will create a steeper water level elevation gradient, resulting in increasing water level elevations upstream of MCDD#1.

Table 5.2. Summary of Culvert Replacement Recommendations

Location	Diam.(in.)	Length	Invert Elevation		Style
			east end	west end	
	Exist/New	ft	ft MSL		
Buffalo Slough (W to E)					
NE 33rd Ave.	- / 48	120	4.0	4.0	HDPE
Broadmoor W	48 / 48	60	4.0	4.0	CSP or HDPE
Broadmoor E	48 / 48	48	4.0	4.0	CSP or HDPE
Whitaker Slough (W to E)					
Colwood W	48 / 72	36	4.5	4.5	CSP or HDPE
Colwood E	48 / 72	36	4.5	4.5	CSP or HDPE

The two culverts at Colwood Golf Course and two culverts at Broadmoor Golf Course are located on golf cart crossings. Construction of these four culverts will use standard excavation techniques to remove the existing culverts and replace them.

The culvert at NE 33rd Avenue will require special construction techniques. NE 33rd Avenue is a 4-lane road and a major connecting road between Marine Drive and Columbia Boulevard. Groundwater levels are also quite high in the area, and would make the use of conventional trenching methods very costly. Consequently, it is recommended that a boring machine be used, and that the existing culvert left in place. The new culvert would be placed to the north of the existing culvert.

5.2.3 Galitski Spings and Flats

5.2.3.1 Galitzski Flats. Currently, a 54-inch-diameter storm sewer pipe drains a 420-acre basin and discharges to an open ditch north of NE Sandy Boulevard and eventually into the Columbia Slough. Recently, the stormwater has been diverted to a wet sedimentation pond built along NE Sandy Boulevard between NE 158th Avenue and 162nd Avenue, prior to discharging into the open ditch. This treated wastewater will then be routed to the proposed constructed wetland on Galitzski Flats. The existing wetland, a reed canarygrass monoculture, will be recontoured and enhanced by planting a variety of native vegetation to provide habitat for a variety of species. The treated stormwater will be used to provide the water necessary to create a diverse wetland.

The constructed wetland will consist of a combination of the following design elements:

- 0.3 acres of deep-water habitat with a bottom elevation more than 18 inches below the normal water surface elevation.

- 1.5 acres of low marsh with a bottom elevation about 6 to 18 inches below the normal water surface elevation.
- 2.0 acres of high marsh with a bottom elevation about 1 to 6 inches below the normal water surface elevation.
- 0.2 acres of semi-wet marsh with a bottom elevation about zero to 24 inches above the normal water surface elevation.

The wetland will be allowed to dry out during summer, with the exception of the deep-water habitat, to mimic natural conditions of wetlands in this watershed.

5.2.3.2 Galitzski Springs. The site consists of gently sloping (2 to 8 percent) terrain incised by several small drainages associated with perennial springs (Figure 8). Water from the hillside springs and seeps drains into a ditch at the bottom of the slope, which carries the flow northeast into the Columbia Slough. Vegetation on the property consists of a mosaic of deciduous forest and shrub thicket, punctuated by occasional openings associated with past disturbance. Several large Western redcedar and big-leaf maple trees occur on the better drained soils of the upper slope. Dominant tree species along the lower slopes include red alder, Oregon ash, and black cottonwood. A narrow band of riparian scrub-shrub vegetation at the base of the slope consists of Scouler's willow, red-osier dogwood, red elderberry, beaked hazelnut, Douglas' hawthorn, clustered and Nootka rose, and snowberry. Himalayan blackberry occurs throughout the property and forms several large (1- to 2-acre) patches.

The subject parcel, with its perennial springs, terrace and slope topography, and varying soil types, offers unique restoration opportunities. The juxtaposition of the forested slope and adjacent wet meadow and emergent wetlands makes this one of the most valuable restoration sites in the project area. The dominant vegetation is forest: cottonwood/ash on the lower slope and mixed hardwood/conifer on the upper terrace. Historic logging operations reduced tree cover, particularly conifers, and the invasion of Himalayan blackberry into disturbed areas prevented natural reforestation. The lack of snags and downed woody debris is clearly evident today. Restoration would focus on increasing forest cover, improving age-distribution, and snag recruitment. This would be accomplished primarily through invasive plant control and revegetation efforts. Restoration would result in an increase in habitat suitability in the three cover types. Recruitment of large snags would require several decades. Existing redcedars and mature maple, alders, and cottonwoods will provide snag habitat within the next 10 to 20 years.

5.3 Real Estate. The Columbia Slough Section 1135 Project involves approximately 19.1 acres of land for initial construction. For construction of the wetland benches, it will require the use existing flood control easements held by MCDD No. 1 for 7.5 miles of the main slough (creating approximately 11.3 acres of new emergent wetland), as well as flood control and construction easements for the five culverts at Buffalo and Whitaker Sloughs. It will require the purchase of 9 acres (Galitzski Springs). The 9 acres at Galitzski Flats have already been purchased by the City of Portland. A new well would be required at Colwood Golf Course due to lowering of water levels.

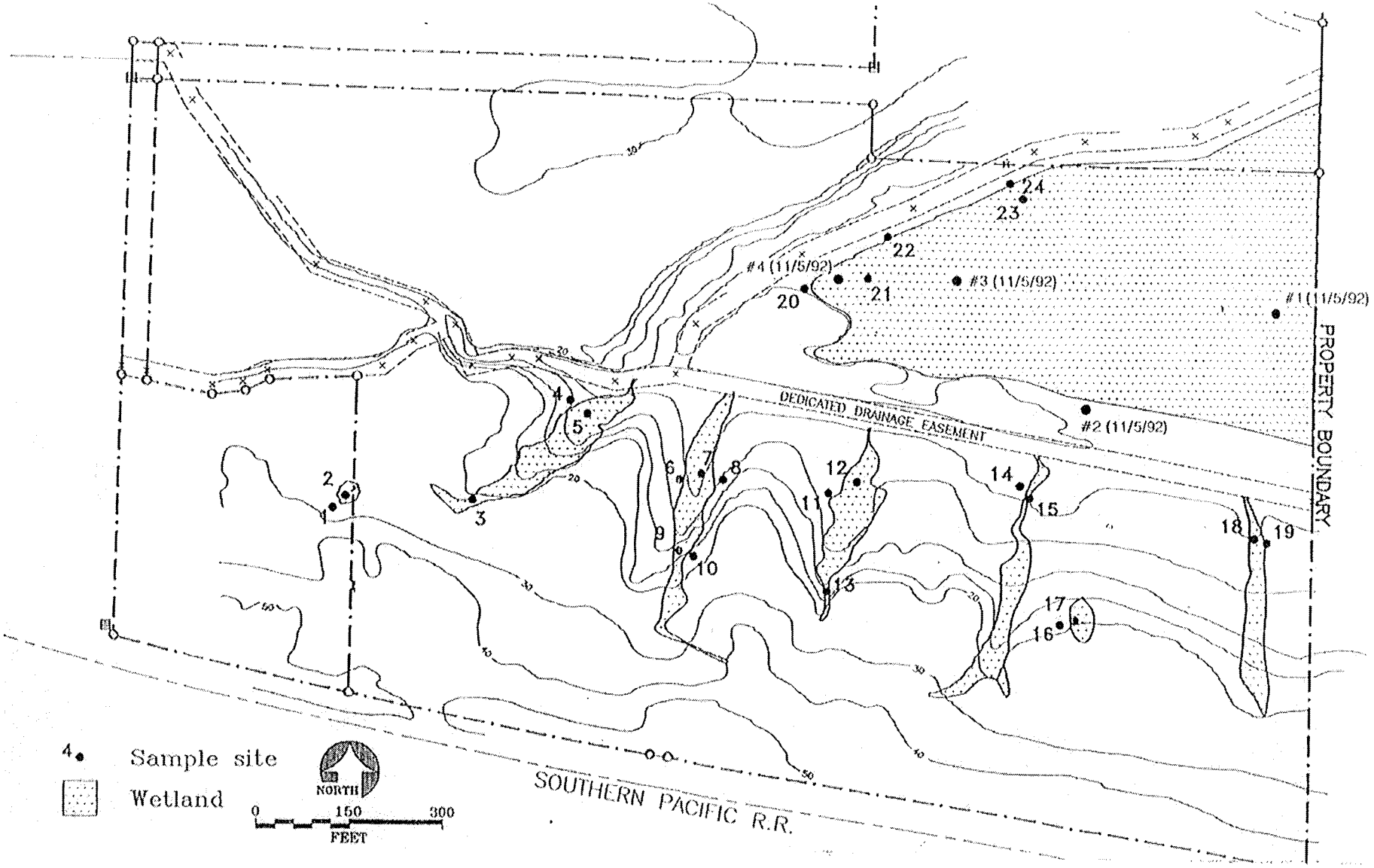

Figure 8. Galitzski Springs. (from SRI/Shapiro, 1993)

Table 5.3. Summary of Lands, Easements, Rights-of-Way, Relocations, and Disposal Areas

	Wetland Benches	Buffalo Slough Culverts	Whitaker Slough Culverts	Galitzski Flats	Galitzski Springs	TOTAL
Lands and Damages	$ -	$ -	$150,000	$230,000	$155,000	$535,000
Non-Federal Sponsor's Costs	$ -	$ 7,500	$ 10,500	$ 20,000	$ 15,000	$ 53,000
Federal Review & Assistance Costs	$ -	$ 1,000	$ 3,000	$ 10,000	$ 10,000	$ 24,000
Subtotal	$ -	$ 8,500	$163,500	$260,000	$180,000	$612,000
Contingency	$ -	$ 2,000	$ 7,000	$ 20,000	$ 45,000	$ 74,000
Total	$ -	$ 10,500	$170,500	$280,000	$225,000	$686,000

5.4 Construction Restrictions

Special conditions were placed on construction of the wetland benches. Native vegetation and silt fencing will be used to aid in erosion control. Sediments within the slough will be handled so that "top" material dredged from undisturbed channel will be on the bottom of the piled material creating the bench. The excavation will be done with shallow cuts to get the top material on the bottom of the disposal site. Material will be placed rather than dumped.

These are additional special conditions placed by DSL on MCDD when MCDD did wetland benches (meandering channel) at Bridgeton Slough:

- Operation shall be conducted in a manner that will minimize any turbidity increase.
- In water work shall be conducted between June 15 and September 15 (we will try to get a waiver on this, since not directly connected to the Columbia or Willamette River except by pumps)
- Petroleum products, chemicals, or other deletorious materials shall not be allowed to enter the water.
- Fill materials and spoils shall be placed above the bankline unless utilized in the shaping and contouring of existing bankline.
- Removal of existing woody vegetation shall be the minimum necessary to achieve the project purpose.
- Areas of streambank disturbance shall be seeded or planted with grass and/or legumes. All exposed soils shall be stabilized immediately after project's completions to prevent erosion and sedimentation.
- The DSL retains the authority to temporarily halt or modify the project in case of excessive turbidity or damage to natural resources.

5.5 Maintenance. Non-native vegetation will be suppressed by cutting blackberries, reed canary grass and other exotic vegetation with chainsaws, weedeaters, hand tools or industrial mowing equipment. Workers will cut all resprouting exotic vegetation three

times during the first year. In years two, three, and five, workers will cut brush once or twice in summer, depending on regrowth. BES will monitor planting survival and exotic vegetation regrowth, and prescribe additional treatments, as needed.

At the end of the 5-year establishment phase, native trees and shrubs should be well established. Stands of young hardwoods and conifers will become very dense, shading out most exotics. Maintenance in these stands should be minimal after 5 years. Shade tolerant weeds such as nightshade, English ivy, and holly will required continued monitoring and treatment. Areas planted with native shrubs, forbs, and wetland emergent plants will require extended maintenance.

Newly established stands will be managed in a variety of ways to achieve resource management objectives. Stands may be thinned to lower densities to allow establishment of understory vegetation and to increase growth of individual plants. Small patches within stands may be cut to provide a weed-reduced environment for the establishment of shrubs and forbs, or dense overstory may be maintained to minimize additional maintenance and planting costs.

5.6 Monitoring. BES has prepared monitoring and documentation guidelines to assess conditions and identify trends to increase continued success of planting projects. Monitoring includes assessment of plant mortality and its causes. BES will interplant areas where stocking falls below a level that will assure occupancy of the site by native plants within 10 years. BES may prescribe other treatments to further reduce plant mortality or to further enhance project areas.

5.7 Local Sponsor Support of Selected Plan. Coordination with the local sponsor and interested parties has been accomplished throughout the feasibility phase. The City of Portland has been conducting many other restoration projects in the Columbia Slough as part of its Columbia Slough Revitalization Plan. It has also played a major role in the development of the Total Maximum Daily Loads (TMDLs) for the watershed. The City of Portland, Bureau of Environmental Services, as well as the Multnomah County Drainage District No. 1, which operates the pump stations and maintains the drainage ways in Columbia Slough, have been closely involved in the development of the recommended plan, and suggested most of the alternatives considered.