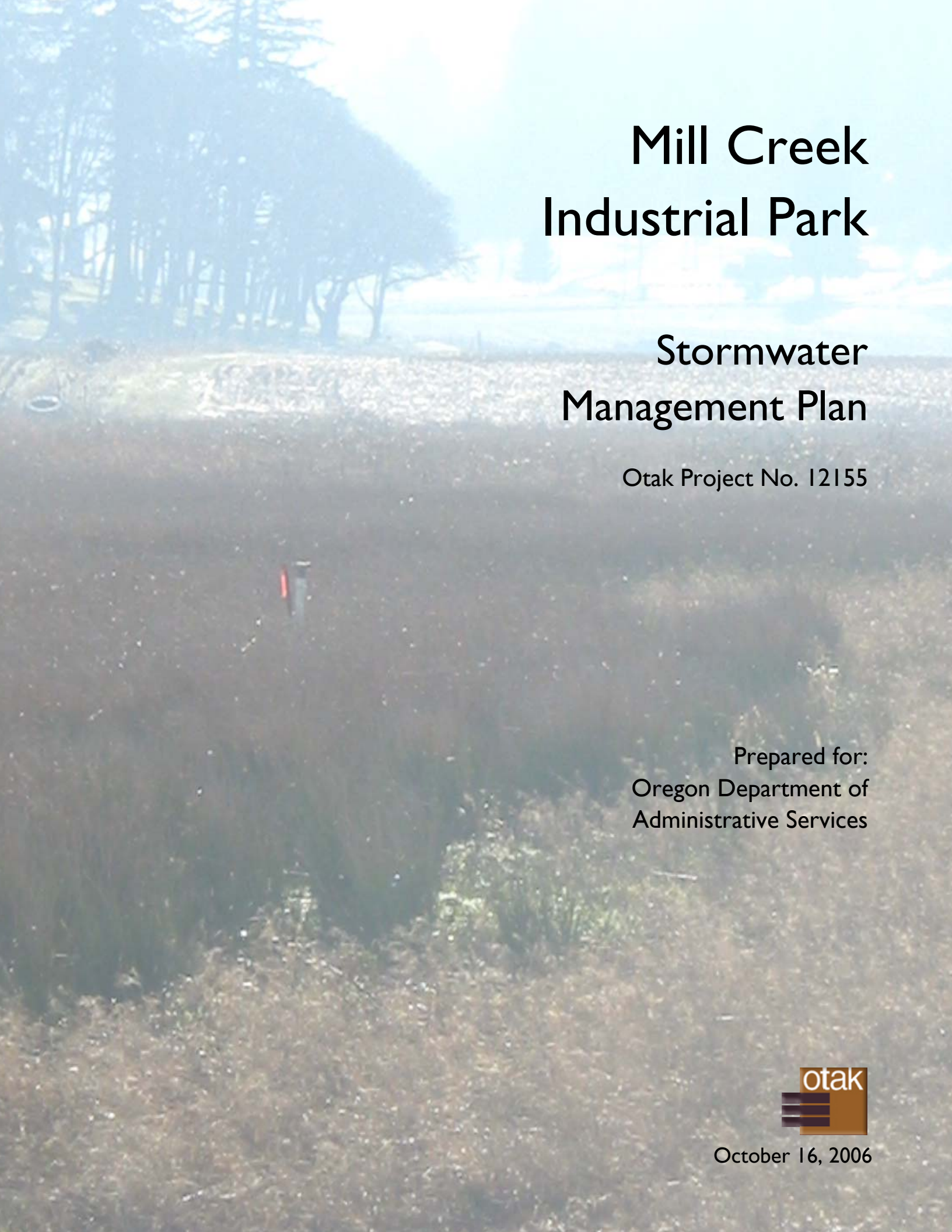

Mill Creek Industrial Park

Stormwater Management Plan

Otak Project No. 12155

Prepared for:
Oregon Department of Administrative Services

October 16, 2006

Acknowledgements

Mill Creek Industrial Park

Stormwater Management Plan

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Prepared for:
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October 16, 2006

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This document, the *"Mill Creek Industrial Park Stormwater Management Plan"*, contains technical information about stormwater management requirements and assumptions for the Mill Creek Industrial Park (MCIP). This document is intended to serve as a technical supplement to the Stormwater Management Agreement between the City of Salem and the State of Oregon, as well as the Mill Creek Industrial Park Covenants, Codes, and Restrictions.

This document is an update and revision to two previous documents:

1) The "Salem Regional Employment Center (SREC) Surface Water Management" memorandum dated February 15, 2005. The "SREC Surface Water Management" memorandum was submitted as part of the Joint Permit Application for review by the following agencies.

- City of Salem
- Oregon Department of State Lands
- Oregon Department of Environmental Quality
- U.S. Army Corps of Engineers
- NOAA Fisheries
- U.S. Fish and Wildlife Service

2) The "Mill Creek Industrial Park Surface Water Management – Phase IB Parcel" memorandum dated August 24, 2005.

1.1 Background

The Oregon Department of Administrative Services (DAS) owns over 2,000 acres of land in Salem, Oregon south of Highway 22. Historically, the Oregon Department of Corrections (DOC) used the land as a prison farm. Currently, there are three prisons operating on the land with various other buildings used by DOC for storage and maintenance facilities. A majority of the land is leased to private individuals for agricultural activities. The State Legislature has earmarked approximately 650 acres of the site for sale as industrial land. The land is included entirely within the Salem Urban Growth Boundary and would be part of the City of Salem. The State and City formed a partnership to create the Mill Creek Industrial Park Master Plan for the site, which is being advanced through a variety of land use approval processes to make the site "shovel ready". Figure 1 is a vicinity map showing the location of the site.

Part of the Master Planning effort included an engineering evaluation of future infrastructure needs to serve the property under fully developed conditions. Surface water management is an integral part of the infrastructure needs for this site. Otak has reviewed the existing hydrology for the MCIP property in Salem, and has estimated infrastructure improvements for surface water management as it is proposed in the MCIP Master Plan. A copy of the MCIP Master Plan concept is shown in Figure 2.

This memorandum provides a summary of the site conditions and assumptions made in the design of the surface water management infrastructure plan for the MCIP Master Plan. It is intended to document the hydrologic impacts anticipated from development of the MCIP and the surface water management strategy designed to mitigate those impacts. The work is based on site observations, City of Salem Stormwater Master Plan documents, and information supplied by City of Salem Public Works staff through personal communications.

1.2 Definitions

The following definitions are helpful in understanding this Stormwater Management Plan.

- *Onsite* — Property located within the limits of the Master Plan study area (approximately 650 acres).
- *Offsite* — Property located outside the Master Plan study limits.
- *Public Stormwater* — Runoff generated by rain that falls on public open space land or public right-of-way and is converted to runoff.
- *Private Stormwater* — Runoff generated by rain that falls on private land and is converted to runoff.
- *Public Stormwater Facility* — Stormwater management facility that is owned and maintained by the City of Salem.
- *Private Stormwater Facility* — Stormwater management facility that is owned and maintained by a non-public entity.
- *EW Road* — New proposed road oriented east to west across site.
- *NS1 Road* — New proposed road oriented north to south between the new EW Road and Aumsville Highway.
- *NS2 Road* — New proposed road oriented north to south between the new EW Road and Turner Road.
- *Pre-developed* — For this project, pre-developed refers to conditions on the site at the time the site Master Plan was developed (2004).
- *Central Open Space* – Master Plan Open Space located between Phase 1A and Phase 1C.
- *Southern Open Space* – Master Plan Open Space located between Phase 1A Industrial Park and Phase 2A.

1.3 Applicable Design Standards and Guidelines

The following set of published stormwater management standards and guidelines were considered during development of the MCIP Stormwater Management Plan.

- City of Salem, Public Works Department, Design Standards for Stormwater Management, 2002.
- City of Salem, Storm Water Master Plan, 2000.
- City of Salem, NPDES Stormwater Management Plan, April 2002.

- Stormwater Management Agreement between City of Salem, Oregon, City of Keizer, Oregon, and Marion County, Oregon, October 2000.
- NOAA HCD Stormwater Online Guidance Document, March 2003. City of Portland, Bureau of Environmental Services (BES), Stormwater Management Manual, September 2002 (City of Portland SMM).

The following set of standards for stormwater management were applied, during development of the Master Plan, to all stormwater management facilities described in this memorandum and should also be adhered to for the future design of both Public and Private Stormwater Management facilities. They are intended to satisfy design standards identified in the NOAA HCD Stormwater Online Guidance Document, and those required by the City of Salem in their Design Standards for Stormwater Management and through a Stormwater Management Agreement between City of Salem, City of Keizer, and Marion County.

2.1 Performance Standards

There are currently four discharge locations from the MCIP project site: two in the Mill Creek basin and two in the Little Pudding River basin. Discharge locations from the MCIP project site should remain the same. No new discharge locations are proposed as part of the MCIP project.

Discharges from the MCIP project site should be managed to match developed discharge durations to pre-developed durations for the range for pre-developed discharge rates from 50 percent of the two-year peak flow up to the full 50-year peak flow. At the time of this Master Planning effort, no continuous flow hydrologic model was readily available for application in Oregon.

During the 1990's, King County developed the "Stream Protection Standard" to approximate the results of a continuous flow hydrologic model used to match flow durations. The "Stream Protection Standard" relies on design storm hydrology predicted by the Santa Barbara Urban Hydrograph (SBUH) method, which is a standard stormwater hydrologic design methodology used in Oregon. The "Stream Protection Standard" specifies that the required storage volume and flow control device for a flow management facility be sized so that:

- The post-developed two-year peak flow matches 50 percent of the pre-developed two-year peak flow;
- The post-developed 10-year peak flow matches the pre-developed two-year peak flow, and;
- The post developed 100-year peak flow matches the pre-developed 10-year peak flow.

The storage volume is then increased by 30 percent without adjusting the flow control device.

Water quality treatment facilities for the MCIP project site are intended to capture and treat approximately 90 percent of the annual runoff volume. Volume-based facilities for stormwater treatment, such as ponds and wetlands, are not applicable to this site due to site constraints resulting from the site's proximity to the airport. All stormwater management facilities designed for pollution reduction should be flow-based facilities, requiring a water quality design storm.

All stormwater treatment facilities should be designed to treat the peak flow from a 24-hour storm event totaling 0.83 inches of precipitation. Evaluation of long-term hourly precipitation records from the Salem Airport indicates that 90 percent of the precipitation falls during a 24-hour period for storm events totaling 0.83 inches or less. The City of Portland has been designing to a similar sized storm event for the past several years. The City of Salem has decided to adopt this design

storm as the standard for this project.

Site topography and proximity to the airport limit the stormwater management facility alternatives for treatment of runoff. Two categories of treatment devices have been identified for this project: pre-treatment and basic treatment. Basic treatment facilities should be designed to meet the performance criteria specified in the current City of Portland SMM. At the time of this memorandum, the BES performance criterion is 70 percent removal of Total Suspended Solids (TSS). Pre-treatment facilities are intended to remove trash, large particles, and oil, grease, or other floatables. Ponded water is necessary to provide flow control of stormwater runoff. Detention ponds are intermittent and should be designed to minimize the depth of water.

Table 2.1 is a summary list of the available facility types that are proposed for use on this site, as well as those facilities which should not be used and are restricted from this site. New technologies, not listed in Table 2.1, that may be developed and become available during the duration of the MCIP site development may be used on this site as long as they have been approved for use in the current (current refers to the time of final design) City of Portland SMM.

Table 2.1
Stormwater management pollution reduction facilities

Proposed Use	Facility
Pre-treatment	Sedimentation manholes Hydrodynamic separators Oil/water separators
Basic Treatment	Vegetated Swales Sand filters Other media filtration devices
Not allowed	Wetponds Wetvaults Constructed wetlands Extended detention ponds Underground Injection

2.2 Private Stormwater Management Requirements

Certain assumptions were made during development of the proposed stormwater management concept. These assumptions will need to become requirements of each private developer as each portion of the site is developed.

- The effective impervious area within the limits of the parcels shown in the MCIP Master Plan should not exceed 80 percent of the total area of the parcel.

- Discharge of runoff to each 300 feet of vegetated swale should be limited to the runoff from a tributary area of 20 acres. The 20 acres must first be allocated to treatment of runoff from the public right-of-way. Since most of the MCIP phases are larger than 20 acres, each phase of the MCIP is likely to require multiple discharge locations to the vegetated swales.
- A pre-treatment device needs to be installed at each discharge location to remove trash and large particles, and to trap floatables carried by the runoff before discharging into the vegetated swale.
- All private stormwater needs to pass through both a Pre-treatment Facility and a Basic Treatment facility before it is reaches an Open Space area with wetland mitigation and/or before it is discharged from the MCIP site.

Additionally, site specific treatment may be required by a private user for compliance with an individual NPDES permit for discharge of industrial stormwater. The level of treatment proposed in the stormwater management plan for this project is intended to address Total Maximum Daily Load (TMDL) requirements presently anticipated for impaired downstream waters (e.g. – Mill Creek, Little Pudding River, and Willamette River). As TMDL load allocations are issued, new methodologies and standards may need to be applied to this project to comply with the change in regulations.

2.3 Planting requirements

Vegetation in and around stormwater management facilities should be limited to plant species included in Tables 2.2, 2.3, & 2.4. Vegetation should be approved by the City of Salem. Adherence to the plant list should minimize the maintenance of the facilities, increase the chance for a successful facility, and reduce the probability that invasive plant species will establish in areas upstream of the mitigation wetlands and provide a seed source that would likely contaminate the mitigation wetlands.

Vegetation used in the Open Space areas should adhere to the Wetland Mitigation Plan where applicable or be approved by the City of Salem in areas that are not part of the Wetland Mitigation Plan.

Every effort should be made to obtain plant stock and seed mixes that are free of invasive plant species. If hydroseeding techniques are used, the application trucks should be thoroughly cleaned to reduce the probability for contamination with invasive plant seeds.

Table 2.2: Approved Plants for Wet to Moist Planting Zone (Swale Bottom to 1.5 feet up the side slope)	
Grasses and Groundcovers	*Carex aperta*, Columbia Sedge *Scirpus microcarpus,* Small flowered (or fruited) Bulrush *Hordeum brachyantherum*, Meadow Barley *Juncus ensifolius*, Dagger-leaf Rush *Juncus oxymeris,* Pointed Rush *Juncus tenuis*, Slender Rush *Juncus patens,* Grooved Rush; Spreading Rush *Glyceria occidentalis*, Manna Grass
Ferns	*Blechnum spicant,* Deer Fern *Polypodium glycrrhiza,* Licorice Fern *Polystichum munitum*, Sword Fern
Shrubs	*Cornus sericea,* Redtwig Dogwood *Physocarpus capitatus*, Pacific Ninebark
Large Shrub / Small Tree	*Salix fluviatalis*, Columbia Willow *Salix Hookeriana*, Piper's Willow *Salix Lucida* (or S. *lasiandra*), Pacific Willow *Salix Scouleriana*, Scoulers Willow *Salix sessilifolia*, Soft leafed Willow *Salix Sitchensis*, Sitka Willow
Conifer and Evergreen Trees	
Deciduous Trees	*Fraxinus latifolia*, Oregon Ash

Table 2.3: Approved Plants for Moist to Dry Planting Zone (Side slopes from 1.5 feet to 3 feet)	
Grasses and Groundcovers	*Aster suspicatus*, Douglas' Aster *Bromus carinatus*, California Brome Grass *Bromus sitchensis*, Alaska Brome *Bromus vulgaris*, Columbia Brome Grass *Lupinus micranthus*, Small Flowered Lupine *Sisyrinchium idahoense,* Blue-eyed Grass *Camassia quamash*, Common Camas *Festuca Occidentalis*, Western Fescue Grass *Deschampsia caespitosa*, Tufted Hairgrass *Elymus glaucus*, Blue Wildrye
Ferns	
Shrubs	*Mahonia aquifolium*, Tall Oregon Grape *Mahonia nervosa*, Dull Oregon Grape *Rosa gymnocarpa*, Baldhip Rose *Rosa nutkana,* Nootka Rose *Rosa pisocarpa,* Swamp Rose *Symphoricarpos albus*, Common Snowberry *Viburnum edule*, Highbush Cranberry; Squashberry
Large Shrub / Small Tree	*Ceanothus sanguinea*, Oregon Redstem Ceanothus *Corylus cornuta*, Western Beaked Hazelnut *Holodiscus discolor*, Oceanspray *Philadelphis lewesii*, Mock Orange *Prunus emarginata* or *P.Virginiana* Bitter or Choke Cherry *Rosa nutkana*, Nootka Rose *Rubus parviflorus*, Thimbleberry *Sambucus cerulea*, Blue Elderberry *Rhamnus purshiana*, Cascara-
Conifer and Evergreen Trees	
Deciduous Trees	*Cornus nuttalii*, Western Flowering Dogwood *Quercus garryana*, Oregon White Oak

Table 2.4: Approved Plants for Dry Planting Zones (Side slopes above 3 feet and upland)	
Grasses and Groundcovers	
Ferns	
Shrubs	*Gaultheria shallon,* Salal *Ribes sanguineum*, Red-flowering Current *Spiraea betulifolia*, Shiny-leaf Spiraea
Large Shrub / Small Tree	*Amelanchier alnifolia*, Western Saskatoon Serviceberry
Conifer and Evergreen Trees	
Deciduous Trees	*Amelanchier alnifolia*, Serviceberry *Quercus garryana*, Oregon White Oak

3.1 Existing Site Hydrology

The project site is located within two different watersheds separated by Aumsville Highway. Areas north of Aumsville Highway drain to the Little Pudding River. Offsite areas to the east and onsite areas south of Aumsville Highway drain to Mill Creek. Figure 3 shows the existing drainage basin boundaries and site discharge locations for the MCIP site.

Onsite runoff flows are conveyed via ditches to one of four site discharge locations. North of Aumsville Highway, the discharge to Little Pudding No. 1 is through a 12-inch culvert under Kuebler Boulevard just south of the Highway 22 underpass. Discharge to Little Pudding No. 2 is through a pair of 60-inch culverts that convey water under Highway 22. South of Aumsville Highway, the ditches are part of an irrigation network that distributes water throughout the site during the growing season, and provides conveyance for drainage during the wet season. Irrigation ditches drain to one of two culvert crossings under Kuebler Boulevard that discharge to Mill Creek. Discharge to Mill Creek No. 1 is through a pair of parallel 48-inch culverts. Discharge to Mill Creek No. 2 is through a single 48-inch culvert under Kuebler Boulevard. Discharge from Mill Creek No. 2 passes through several downstream gravel ponds before entering Mill Creek.

Offsite runoff from approximately 550 acres of upland area east of Deer Park Road flows across Deer Park Road onto the site and overland to the irrigation ditches south of Aumsville Highway. Most of that flow is routed towards the Mill Creek No. 1 discharge point. However, some overflow contributes to the Mill Creek No. 2 discharge, and probably provides some of the source water to wetlands along the way.

A Santiam Water Control District dam on Mill Creek controls water levels in the irrigation ditches. During the growing season, flashboards on the dam are in place and backwaters flow from Mill Creek into the irrigation system on the site. During the rainy season, the flashboards are removed and allows the irrigation ditches to drain the project site.

Much of the project site is covered with gravelly loam and silty loam soils that have shallow groundwater and low infiltration rates. Figure 4 is a copy of the NRCS Soils Survey Map for this site. Pockets of hydric soil are present on the site and help maintain several farmed wetlands. Several of the irrigation ditches are considered jurisdictional waterways by either the US Army Corps of Engineers (COE) or the Oregon Department of State Lands (DSL).

3.2 Site Constraints

Groundwater is expected to be near the surface during the winter months. Monitoring stations were installed during Spring 2004 and data is being collected for use in future design phases of the project. Shallow groundwater limits the possibilities for engineered infiltration facilities, but can be beneficial for design of mitigation wetlands and vegetated swales.

Much of the site is located within a 10,000-foot buffer around the Salem Airport. Federal Aviation Administration requirements discourage the use of tall trees and the creation of environments that

will attract waterfowl. This restricts the use of water quality ponds and other permanent open water facilities. The open space wetlands are intended to be wet areas of temporarily shallow water. Trees and shrubs will be densely planted in the open space wetlands to discourage use by large waterfowl.

The Santiam Water Control District operates a dam on Mill Creek that backwaters surface water from Mill Creek onto the MCIP site during the annual growing season. Most of the existing irrigation ditches on the MCIP site will be converted to drainage and conveyance swales. However, the dam on Mill Creek may continue to operate during the growing season and backwater surface water from Mill Creek through the culvert under Kuebler Blvd at the location of the Mill Creek No. 1 discharge. This would require stormwater runoff during the irrigation season to be routed north to Mill Creek No. 2 discharge location. Stormwater would be routed to Mill Creek discharge No. 2 through either; the emergency overflow ditch along Kuebler Boulevard; or, the emergency overflow pipe connection between the Southern Open Space and the Central Open Space. An alternative irrigation system design may be considered. The alternative design could rely on pumps to withdraw water from Mill Creek instead of backwatering surface water from Mill Creek onto the SREC site using the dam. Either irrigation alternative will require fish screens at the point of diversion from Mill Creek.

3.3 Proposed MCIP

The MCIP Master Plan calls for 322.6 acres of land zoned for industrial uses, 79.2 acres zoned for an industrial park, 103.5 acres zoned for a business park, and 10 acres zoned for a service center. The public will retain ownership of 109.9 acres of open space and approximately 26.2 acres of new right-of-way. Figure 2 shows the Master Plan concept assumed for this stormwater management plan.

The developed areas are expected to impact a total of 11.04 acres of the wetlands. Two large open space areas totaling 94.9 acres of the total 109.9 acres were defined in the Master Plan to reduce wetland impacts. Existing wetlands in the open space areas will be enhanced and/or expanded as mitigation. Much of the hydrology for the wetland mitigation areas will be supplied by stormwater runoff.

The proposed infrastructure to manage stormwater is shown schematically in the attached Figure 5. The concept is intended to provide vegetated swales parallel to the roadways to treat stormwater runoff for both public right-of-way and private runoff from adjacent properties. The vegetated swales also function as the primary conveyance system for the development.

Parcel IB at the northern end of the MCIP is in a separate watershed from the rest of the sites. Surface water management requirements are to be designed to the same standards as the rest of the site, but location and design of the necessary surface water management facilities for this parcel have been left to the discretion of the site developer.

4.1 Conveyance

Conveyance throughout the site is a combination of closed pipe systems, open channels, vegetated swales, and culverts. South of Aumsville Highway, much of the conveyance system will be routed to either the Central Open Space or the Southern Open Space areas. Stormwater outfalls that discharge directly to an open space should be protected with riprap to reduce scour. Discharge locations for the MCIP site will not change. There will continue to be four discharge locations, two to Mill Creek and two to the Little Pudding River.

The Department of Public Safety Standards and Training (DPSST) has agreed with the City of Salem to provide a 42- inch pipe connection to a detention pond on their property immediately to the east of MCIP Parcel IB. Connection to this 42-inch pipe provides a third discharge location that contributes flow to the Little Pudding River. Stormwater discharges to the DPSST facilities will rejoin flows from Parcel IB near the Little Pudding No. 2 discharge before being conveyed beneath Highway 22. Figure ___ shows the approximate location of the 42-inch pipe.

The City of Salem Stormwater Master Plan identified the existing 48-inch culvert at the Mill Creek No. 2 discharge location, for replacement with a 72-inch culvert. A 72-inch culvert will provide a controlled overflow route under Kuebler Boulevard. The existing structure located at the inlet to the existing culvert will also need to be removed and replaced with a redesigned control structure to maintain existing peak flows to Mill Creek.

The existing inlet structure to the twin culverts at the Mill Creek No. 1 discharge will need to be removed and replaced with a redesigned inlet structure to provide maintenance access and reduce the potential flooding caused by debris accumulation.

Two conveyance connections are proposed to direct overflow to the Central Open Space. One conveyance connection directs emergency overflow from the Southern Open Space to the Central Open Space. The other conveyance connection allows for emergency overflow from Mill Creek No. 1 discharge location to Mill Creek No. 2 discharge location. The control structure at Mill Creek No. 2 discharge location should be designed to accommodate emergency overflow to the 72-inch culvert.

A flow splitter will be required on Deer Park Road to maintain an existing source of water to the

wetlands that will be located in the Central Open Space and upstream of the Central Open Space. The flow splitter should send low flows towards the Central Open Space, while high flows should continue south through the conveyance system on Deer Park Road.

Conveyance systems should be sized and designed per City of Salem Public Works Department Design Standards for Stormwater Management. Open channels may need to be utilized for conveyance due to the flat topography over much of the site.

4.2 Flow Control

The use of vegetated swales should provide significant opportunity for smaller, more frequent rain events to infiltrate to shallow soil depths and flow subsurface to the open space wetlands. Larger rain events will provide much of the hydrology necessary to enhance existing farmed wetlands, restore missing wetlands, or create new wetlands. The open space topography, stormwater volumes, and required wetland hydrology will require further modeling during design to evaluate specific needs for each wetland mitigation site within the open space areas. Continued coordination is necessary so that wetland vegetation receives enough water for success of the wetland, while not creating a situation that over-inundates the wetland areas. The design of the inlet structures at each discharge location will need to control stormwater volumes to regulate water levels within the open space wetlands.

Flow attenuation from the open space wetland areas is expected to reduce peak discharges from the site to the standards described in Section 2.1. The open space wetland areas are expected to provide enough flow attenuation to mitigate for the portion of the MCIP site that discharges to Mill Creek. Developers of Parcel IB will need to provide stormwater detention facilities that meet the performance standards described in Section 2.1. Physical design standards (such as side slopes, water depth, and access requirements) should adhere to City of Salem Public Works Department Design Standards for Stormwater Management.

4.3 Pollution Reduction

Vegetated swales in drainage easements parallel to the roads will collect runoff and allow for sedimentation and filtration of pollutants before discharging to the open space wetlands. The attached Figures 6A, 6B, & 6C shows the integration of the vegetated swales into a typical cross-section of the rights-of-way. Totaling more than seven miles in length, the vegetated swales have sufficient capacity to treat the public rights-of-way in addition to the MCIP properties that discharge to them.

Additional privately owned and maintained treatment facilities are required on properties that are not able to discharge to a vegetated swale along the roadway due to site configuration and topography. The following list of Master Plan development phases will need to design and construct basic treatment facilities (as described in Section 2.1) at each discharge location to reduce pollution

carried by the runoff before discharging to the public storm system or public open space.

Phase IA – Business Park
Phase IA – Service Center
Phase IB
Phase IIA (south of EW Road)
Phase IIB (northern portion)

Future development or redevelopment of offsite properties east of Deer Park Road will need to provide pollution reducing stormwater treatment facilities to treat all of their runoff before it reaches this project site, as well as detention for new impervious surfaces.

4.4 Variation to the Concept

Ditches on Deer Park

The proposed stormwater concept includes piped conveyance systems along Deer Park Road to collect and route offsite runoff to a few select locations and then across the MCIP site to an open space area. It is assumed that construction of vegetated swales is feasible to reduce pollutants from Deer Park Road runoff, but the swales will not have treatment capacity or conveyance capacity to handle all of the offsite runoff that flows across Deer Park Road. It is also assumed that the construction of open channel ditches for the safe conveyance of offsite runoff along Deer Park Road is further limited by site topography. However, accurate field survey data collected during future design phases may confirm the feasibility of open channel conveyance ditches along Deer Park Road. Open conveyances may be less expensive than an equivalent piped alternative but can require more maintenance.

5.1 Impervious Area

Development outside of the rights-of-way will limit the effective impervious area to a maximum of 80 percent of the total developed area. Development within the right-of-way is expected to result in 13.9 impervious acres. The remaining land planned for development is estimated to result in 295.4 new impervious acres in the Mill Creek Watershed and 116.9 impervious acres in the Little Pudding Watershed. Table 5.1 summarizes the impervious area assumptions.

Table 5.1
Summary of Impervious Area, Total Area, and Site Composition Estimates By Location

Location	Land Use	Impervious Area per Location (acres)	Total Area per Location (acres)	Location Area (% of Total Site)
Phase IA	Industrial Park	63.4	79.2	12.1
Phase IA	Business Park	57.2	71.5	10.9
Phase IA	Service Center	8	10	1.5
Phase IB	Industrial	116.9	146.1	22.3
Phase IC	Industrial	41	51.2	7.8
Phase IIA	Industrial	100.2	125.3	19.2
Phase IIB	Business Park	25.6	32	4.9
Central Open Space	Open Space	0	72.7	11.1
South Open Space	Open Space	0	26.2	4.0
Mill Creek Buffer	Open Space	0	11	1.7
Right-of-way	Road	11.1	11.1	1.7
Right-of-way	Sidewalk	2.8	2.8	0.4
Right-of-way	Vegetated Swales	0	6.9	1.1
Right-of-way	Open Channel	0	2.5	0.4
Right-of-way	Planter Strips	0	5.8	0.9
	SITE TOTALS	426.2	654.3	100.0

The entire Mill Creek Watershed is approximately 110 square miles (70,400 acres) according to the "Mill Creek Watershed Section 205 Flood Control Feasibility Study" published by the COE, Portland District February 2002. The Cities of Salem, Turner, Aumsville, Sublimity, and Stayton are all partially or wholly located within the Mill Creek Watershed. Using maps contained in the study, the total area of the watershed located within city limits is estimated to be less than 14 percent of the total watershed. Since none of the cities are fully developed, or entirely impervious, it is reasonable to assume that the total impervious area within the Mill Creek Watershed is less than 10 percent of the total watershed. Much of the impervious area in the watershed is attributed to portions of the City of Salem located downstream of the project site.

5.2 Flow Control

No continuous flow hydrologic models are available in Oregon for this project. Therefore the Stream Protection Standard developed by King County in the early 1990's was used to approximate the results of a continuous flow hydrologic model to match flow durations. The Stream Protection Standard relies on design storm hydrology predicted by the SBUH Method, a standard stormwater hydrologic design methodology used in Oregon.

The City of Salem XP-SWMM model used for the Mill Creek Basin Stormwater Master Plan was modified to simulate conditions on the MCIP site before and after development. The model was used to estimate the flow attenuation resulting from the Open Space Wetland areas. Table 5.2 and Table 5.3 summarize the results of the XP-SWMM model. The results demonstrate that the flow duration of the two discharges to Mill Creek can be maintained after development.

Table 5.2
Discharge to Mill Creek No. 1 (south)

	Existing		Proposed	
Return Period	(cfs)		(cfs)	Return Period
½ of 2-year	54	<	54	2-year
2-year	108	<	93	10-year
10-year	136	<	133	100-year

Table 5.3
Discharge to Mill Creek No. 2 (north)

	Existing		Proposed	
Return Period	(cfs)		(cfs)	Return Period
½ of 2-year	28	<	28	2-year
2-year	56	<	44	10-year
10-year	72	<	69	100-year

The developer will need to design a stormwater management system for Phase IB that will achieve similar results for the two discharge locations north of Aumsville Highway in the Little Pudding River Watershed. The developer will need to follow the performance standards as described earlier in Section 2.1.

5.3 Pollution Reduction

Water quality is achieved through the use of vegetated swales for all of the public right-of-way. The vegetated swales should have sufficient capacity to treat runoff from many of the private properties as well, assuming that development adheres to the assumptions described in this memorandum. It is estimated that each 300 feet of swale length can treat the runoff from approximately 20 acres of the

site. Private phases of the development larger than 20 acres will have to design their conveyance system so that no more than 20 acres of impervious surface is collected and routed to each 300 feet of swale. Impervious area from the right-of-way should first be considered when calculating the impervious area contributing to each swale. Figure 7 shows one possible scenario of how private phases could be subdivided and discharge to the vegetated swales. It was determined that areas larger than 20 acres generated flow conditions outside the desired operating conditions of the swales.

There are two types of swales as depicted in the typical details shown in Figures 8 and 9. Vegetated Swale – Type 1 is intended for locations where the tributary area is primarily right-of-way and there is not likely to be more than one (up to 20 acre) discharge from private property. For locations where the swale is providing treatment and conveyance of stormwater for several private discharges for a long distance, the Vegetated Swale – Type 2 is necessary. The Vegetated Swale – Type 2 provides an outlet approximately every 300 feet for the water quality flow to be conveyed in a small pipe after passing through the treatment length of swale. High flows will be conveyed by the swale itself.

Properties that are not able to discharge to the roadside treatment swales will need to provide their own equivalent treatment systems as described in Section 2.0. The private treatment facilities will continue to need a pre-treatment device as well as a basic treatment device.

Vegetated swales should be designed to operate within the following criteria:

- Minimum Length = 100 feet
- Bottom Width = 8 feet
- Side Slopes = 3H:1V or flatter
- Minimum Constructed Depth = 3 feet
- Maximum Velocity during Water Quality Event = 1 foot per second
- Maximum Water Quality Depth of Flow = 1 foot
- Maximum Longitudinal Slope = 1 percent
- Minimum Hydraulic Residence Time = 9 minutes
- Maximum Tributary Area = 20 acres
- Manning's Roughness for Flow Depths up to 0.4 feet during Water Quality Event = 0.25
- Manning's Roughness for Flow Depths above 0.4 feet during Water Quality Event = 0.1
- Manning's Roughness during the Conveyance Design Flow Event = 0.03
- Maximum Conveyance Design Depth of Flow = 2 feet

As an example, assume a 20 acre portion of the industrial site is to be discharged to one of the vegetated swales along the roadway.

Area = 20 acres
Percent Impervious is 100 percent
Impervious Area = 20 acres
Curve Number = 98
Time of Concentration = 10 minutes
Water Quality Precipitation Total = 0.83 inches
Water Quality Design Flow = 3.3 cubic feet/second

A vegetated swale of 285 feet in length, and having the following geometry will effectively treat the stormwater from this 20 acre site example.

Bottom Width = 8 feet
Water Quality Depth of Flow = 0.63 feet
Slope = 0.003 feet/feet
Side Slope = 3H:1V
Velocity = 0.53 feet/second

It is anticipated that site build out could take 20 years or more. It is assumed the stormwater infrastructure will be built in phases, as portions of the MCIP site are developed. Elements of the stormwater infrastructure that are necessary to support development of each phase of the MCIP are summarized in Table 6.1.

Interim configurations will have to be designed to accommodate the stormwater management needs of the site as development occurs. Best management practices will be necessary throughout the duration of development at the MCIP to control the transport of sediment from portions of the site that are disturbed due to construction activity, or continued agricultural activities so that erosion does not impact the performance of permanent stormwater facilities (such as the vegetated swales) or damage wetland mitigation areas.

Table 6.1

Stormwater Infrastructure Phasing Table

MCIP Land	Conveyance	Flow Control	Pollution Reduction	Wetland Impacts/Mitigation
Central Open Space	Open channel cuts will be needed to enhance existing and mitigated wetland areas by improving flow distribution between and through the wetland areas	Improved hydrology to the existing and mitigated wetland areas will improve wetland function and behave as a large storage area to reduce discharge rates to Mill Creek.	Treatment of stormwater must occur before discharge to this open space area.	Wetland enhancement, restoration, and creation could occur in this open space to mitigate for impacts from other phases.
Southern Open Space	Open channel cuts will be needed to enhance existing and mitigated wetland areas by improving flow distribution between and through the wetland areas	Improved hydrology to the existing and mitigated wetland areas will improve wetland function and behave as a large storage area to reduce discharge rates to Mill Creek.	Treatment of project stormwater must occur before discharge to this open space area. Off-site flows from east of Deer Park Rd. must be treated as development and redevelopment contributing to the runoff across the project site occurs.	Wetland enhancement, restoration, and creation could occur in this open space to mitigate for impacts from other phases.
Mill Creek Buffer Open Space	Conveyance provided by combination of vegetated swales and overflow pipe through Mill Creek Buffer Open Space.	No flow control required	No pollution reduction required. Vegetated swales in Mill Creek Buffer Open Space are to provide conveyance and treatment of runoff from Turner Road and Phase IA – Industrial Park	Existing wetlands to be avoided.
Aumsville Hwy R.O.W.	Roadside swales.	Phase IB will need to incorporate flow control for runoff from the northern half of Aumsville Hwy with Phase IB runoff before discharging to the north. The southern half of the road will be routed to the Central Open Space.	Roadside swales.	Impacts to be mitigated in the southern or central open space.
Road NS1 R.O.W.	Conveyance provided by vegetated swales along east side of road. Probably 3 culvert crossings will be needed to convey flows under the road. Discharge is to the Central open space.	Provided by the roadside swales and the central open space.	Provided by the vegetated swales along the east side of the road.	Impacts to be mitigated in the southern or central open space.
Road EW R.O.W.	Conveyance of flow down the steep grade from Deer Park Rd. should be through pipes until the grade flattens and the pipes can discharge to vegetated swales along both sides of the EW Road. Conveyance pipes will discharge to the existing irrigation channel West of the Southern Open Space. The side slopes of the existing irrigation channel need to be regraded to a more stable slope and planted.	Offsite flows to be reduced by the southern open space to mitigate for increased runoff rates from NS2 Road.	Provided by the vegetated swales to be constructed along side the EW Road	Impacts to be mitigated in the southern or central open space.
Road NS2 R.O.W.	Conveyance provided by combination of vegetated swales and overflow pipe under the NS2 road.	Offsite flows to be reduced by the southern open space to mitigate for increased runoff rates from NS2 Road.	Provided by the vegetated swales along the east side of the EW Road.	Impacts to be mitigated in the southern or central open space.
Deer Park Rd. R.O.W.	Conveyance provided by vegetated swales along side of road.	Flow control required if Deer Park Rd. is widened. Increased flow to be reduced by the southern open space, but will require facilities to be constructed for pollution reduction of runoff from Deer Park Rd. to treat runoff before it is discharged to Southern Open Space.	Vegetated Swales need to be provided along side of Deer Park Rd. if road is improved.	Impacts to be mitigated in the southern or central open space.
Turner Road R.O.W.	Conveyance of flow down the steep grade from Deer Park Rd. should be through pipes until the grade flattens and the pipes can discharge to vegetated swales along the north side of Turner Road.	Offsite flows to be reduced by the southern open space to mitigate for increased runoff rates from Turner Road.	Provided by the vegetated swales along the north side of the road.	Impacts to be mitigated in the southern or central open space.
Kuebler Blvd. R.O.W.	Existing conveyance system will need to be adjusted at the outfalls to connect to drainage system modifications resulting from this project.	No flow control is required as a result of this project.	Vegetated swales will need to be constructed along the east side of Kuebler Blvd. to treat runoff from Kuebler Blvd that discharges to the Central Open Space.	Impacts to be mitigated in the southern or central open space.
Offsite	Collected and conveyed along Deer Park Road through pipes to multiple locations and discharged to conveyance system on site.	Flow control facilities will need to be constructed by offsite new development or redevelopment that contributes runoff to this project as it occurs.	Pollution Reduction facilities will need to be constructed by offsite new development or redevelopment that contributes runoff to this project as it occurs.	No impacts resulting from this project.
Phase IA - Industrial Park	Site to discharge at multiple locations along NS2 Road and Mill Creek Buffer Open Space. Each discharge location will be to a separate length of vegetated swale.	Offsite flows to be reduced by the southern open space to mitigate for increased runoff rates from Phase IA.	Pre-treatment device required at each discharge location to remove trash and larger particles before discharge to public vegetated swales.	Impacts to be mitigated in the southern or central open space.
Phase IA - Business Park	Site to discharge to Central Open Space.	Flows to be reduced by the Central Open Space to mitigate for increased runoff rates from Phase IA – Business Park.	Need to provide pollution reduction facilities to treat all site runoff prior to discharge to Central Open Space.	Impacts to be mitigated in the southern or central open space.
Phase IA - Service Center	Site to discharge to Flood Overflow Channel.	Flows to be reduced by the Central Open Space to mitigate for increased runoff rates from Phase IA – Service Center	Need to provide pollution reduction facilities to treat all site runoff prior to discharge to Flood Overflow Channel.	No impacts
Phase IB	Needs conveyance. Discharge to the north and northwest.	Need to provide flow control facility designed to NOAA stormwater guidelines. May use open space area along DPSST property. May be some detention capacity available in DPSST project.	Needs to provide pollution reduction. May use open space area along DPSST property.	Existing wetlands under DSL jurisdiction only. Plan is to mitigate in the central open space. Mitigation does not have to be completed before fill. The time delay between fill and mitigation will increase the mitigation ratio.
Phase IC	Site to discharge to public vegetated swale along frontage road.	Flows to be reduced by the Central Open Space to mitigate for increased runoff rates from Phase IC	Pre-treatment device required at each discharge location to remove trash and larger particles before discharge to public vegetated swales. Direct discharges to Central Open Space would require a private vegetated swale to treat all site runoff prior to discharge.	Impacts to be mitigated in the southern or central open space.
Phase IIA (North)	Site to discharge at multiple locations along NS1 Road and EW Road. Each discharge location will be to a separate length of vegetated swale.	Flows to be reduced by the Central Open Space to mitigate for increased runoff rates from Phase IIA (North)	Pre-treatment device required at each discharge location to remove trash and larger particles before discharge to public vegetated swales.	Impacts to be mitigated in the southern or central open space.
Phase IIA (South)	Site to discharge to Southern Open Space. Preferably via the proposed pipe from Deer Park Rd.	Flows to be reduced by the Southern Open Space to mitigate for increased runoff rates from Phase IIA (South)	Need to provide pollution reduction facilities to treat all site runoff prior to discharge to Southern Open Space (or pipe from Deer Park Rd.).	No impacts
Phase IIB	Site to discharge to piped conveyance system on Turner Rd. Some portion of the site may be discharged to pipe along north edge of Phase IIB.	Offsite flows to be reduced by the southern open space to mitigate for increased runoff rates from Phase IIB.	Need to provide pollution reduction facilities to treat all site runoff prior to discharge.	No impacts

Until the monitoring period has ended and the mitigation wetlands in the open space areas are established, the Oregon Department of Administrative Services (DAS), as the 404 permit applicant, will be responsible for maintenance of the open space areas. After establishment, the open space areas will be transferred to the City of Salem. The Salem Parks Department will then become responsible for maintenance of the open space areas. The open space areas provide much of the flow attenuation required for the site.

The City's Public Works Department inspectors will visit MCIP stormwater facilities annually to evaluate their operating condition and request maintenance actions be taken if problems are observed.

The City of Salem Public Works Department also employs maintenance crews to maintain roadways and public conveyance systems located within public right-of-ways.

Stormwater facility types allowed by this MCIP Stormwater Management Plan include; vegetated swales, sand filters, detention ponds for flow control, various pre-treatment technologies, and proprietary devices. Recommended operation and maintenance of the approved facility types are shown in Tables 7.1, 7.2, 7.3, and 7.4.

Operation and maintenance of proprietary stormwater devices shall follow the manufacturer's recommendations.

Responsibility for maintenance of stormwater management facilities throughout the MCIP is defined in the "Stormwater Management Agreement".

Table 7.1:Recommended Operations and Maintenance for Vegetated Swales
Vegetated Swales are planted open channels that trap pollutants by filtering and slowing flows, allowing particles to settle out. All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability, at a minimum, quarterly for the first 2 years from the date of installation, 2 times per year thereafter, and within 72 hours after each major flood event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:
Swale Inlet (such as curb cuts or pipes) shall maintain a calm flow of water entering the swale. • Source of erosion shall be identified and controlled when native soil is exposed or erosion channels are forming. • Sediment accumulation shall be hand-removed with minimum damage to vegetation using proper erosion control measures. Sediment shall be removed if it is more than 4" thick or so thick as to damage or kill vegetation. • Inlet shall be cleared when conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected. • Rock splash pads shall be replenished to prevent erosion.
Side Slopes shall be maintained to prevent erosion that introduces sediment into the swale. • Slopes shall be stabilized and planted using appropriate erosion control measures when native soil is exposed or erosion channels are forming.
Swale Media shall allow stormwater to percolate uniformly through the landscape swale. • Debris in quantities that inhibit operation shall be removed upon discovery.

Swale Outlet shall maintain sheet flow of water exiting swale unless a collection drain is used. Source of erosion damage shall be identified and controlled when native soil is exposed or erosion channels are forming.

- Outlets such as drains and overland flow paths shall be cleared when 50% of the conveyance capacity is plugged.
- Sources of sediment and debris shall be identified and corrected.

Vegetation shall be healthy and dense enough to provide filtering while protecting underlying soils from erosion. Mulch shall be replenished as needed to ensure survival of vegetation.

- Vegetation, large shrubs or trees that interfere with landscape swale operation shall be pruned or removed.
- Fallen leaves and debris from deciduous plant foliage shall be removed if necessary.
- Nuisance and prohibited vegetation from the Pre-Approved Plant List (such as blackberries and English Ivy) shall be removed when discovered. Invasive vegetation contributing up to 25% of vegetation of all species shall be removed and replaced.
- Dead vegetation and woody material shall be removed to maintain less than 10% of area coverage or when swale function is impaired. Vegetation shall be replaced within 3 months, or immediately if required to maintain cover density and control erosion where soils are exposed.

Spill Prevention measures shall be exercised when handling substances that contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.

Training and/or written guidance information for operating and maintaining swales shall be provided to all property owners and tenants within the Mill Creek Industrial Park. A copy of the O&M Plan shall be provided to all property owners and tenants.

Access to the swale shall be safe and efficient. Egress and ingress routes shall be maintained to design standards. Roadways shall be maintained to accommodate size and weight of vehicles, if applicable.

- Obstacles preventing maintenance personnel and/or equipment access to the swale shall be removed.
- Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.

Insects & Rodents shall not be harbored in the sand filter. Pest control measures shall be taken when insects/rodents are found to be present.

- If sprays are considered, then a mosquito larvicide, such as Bacillus thurendensis can be applied only if absolutely necessary, and only by a licensed individual or contractor.
- Holes in the ground located in and around the sand filter shall be filled.

Check Dams shall control and distribute flow.

- Causes for altered water flow shall be identified, and obstructions cleared upon discovery.
- Causes for channelization shall be identified and repaired.

Table 7.2: Recommended Operations and Maintenance for Sand Filters
Sand filters consist of a layer of sand in a structural box used to trap pollutants. The water filters through the sand and then flows into the surrounding soils or an underdrain system that conveys the filtered stormwater to a discharge point. All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability. These inspections shall occur, at a minimum, quarterly for the first 2 years from the date of installation, and 2 times per year thereafter, and within 72 hours after each major storm event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:
Filter Inlet shall allow water to uniformly enter the sand filter as calm flow, in a manner that prevents erosion. • Inlet shall be cleared of sediment and debris when 40% of the conveyance capacity is plugged. • Source of erosion shall be identified and controlled when native soil is exposed or erosion channels are forming. • Sediment accumulation shall be hand-removed with minimum damage to vegetation using proper erosion control measures. Sediment shall be removed if it is more than 4 inches thick or so thick as to damage or kill vegetation. • Rock splash pads shall be replenished to prevent erosion.
Reservoir receives and detains stormwater prior to infiltration. If water does not drain after a storm event within a period specified in the design, sources of clogging shall be identified and corrective action taken. • Debris in quantities sufficient to inhibit operation shall be removed routinely (e.g., no less than quarterly), or upon discovery. • Structural deficiencies in the sand filter box including rot, cracks, and failure shall be repaired upon discovery.
Filter Media shall allow stormwater to percolate uniformly through the sand filter. If water remains 36-48 hours after storm, sources of possible clogging shall be identified and corrected. • Sand filter shall be raked and if necessary, the sand/gravel shall be excavated, and cleaned or replaced. • Sources of restricted sediment or debris (such as discarded lawn clippings) shall be identified and prevented. • Debris in quantities sufficient to inhibit operation shall be removed no less than quarterly, or upon discovery. • Holes that are not consistent with the design structure and allow water to flow directly through the sand filter to the ground shall be filled.
Underdrain Piping (where applicable) shall provide drainage from the sand filter, and Cleanouts (where applicable) located on laterals and manifolds shall be free of obstruction, and accessible from the surface. • Underdrain piping shall be cleared of sediment and debris when conveyance capacity is plugged. Cleanouts may have been constructed for this purpose. • Obstructions shall be removed from cleanouts without disturbing the filter media.
Overflow or Emergency Spillway conveys flow exceeding reservoir capacity to an approved stormwater receiving system. • Overflow spillway shall be cleared of sediment and debris when 50% of the conveyance capacity is plugged. • Source of erosion damage shall be identified and controlled when erosion channels are forming. • Rocks or other armament shall be replaced when sand is exposed and eroding from wind or rain.

Vegetation

- Vegetation, large shrubs or trees that limit access or interfere with sand filter operation shall be pruned.
- Fallen leaves and debris from deciduous plant foliage shall be raked and removed.
- Nuisance and prohibited vegetation from the Pre-Approved Plant List (such as blackberries and English Ivy) shall be removed when discovered. Invasive vegetation contributing up to 25% of vegetation of all species shall be removed and replaced.

Spill Prevention measures shall be exercised when handling substances that contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.

Training and/or written guidance information for operating and maintaining swales shall be provided to all property owners and tenants within the Mill Creek Industrial Park. A copy of the O&M Plan shall be provided to all property owners and tenants.

Access to the swale shall be safe and efficient. Egress and ingress routes shall be maintained to design standards. Roadways shall be maintained to accommodate size and weight of vehicles, if applicable.

- Obstacles preventing maintenance personnel and/or equipment access to the swale shall be removed.
- Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.

Insects & Rodents shall not be harbored in the sand filter. Pest control measures shall be taken when insects/rodents are found to be present.

- If sprays are considered, then a mosquito larvicide, such as Bacillus thurendensis can be applied only if absolutely necessary, and only by a licensed individual or contractor.
- Holes in the ground located in and around the sand filter shall be filled.

Table 7.3: Recommended Operations and Maintenance for Pre-Treatment Facilities
Pre-treatment facilities operate using the law of gravity to settle large particles and on the principal that oil and water are immiscible (do not mix) and have different densities. Oil, being less dense than water, floats to the surface. Variations on the pre-treatment device can include a sedimentation manhole or an oil/water separator. Some proprietary devices enhance settling by altering the internal hydrodynamics. Pre-treatment facilities shall be inspected and cleaned quarterly. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:
Inlet Pipe shall be inspected for clogging or leaks where it enters the facility during every inspection and cleanout. • Debris/sediment that is found to clog the inlet shall be removed, tested, and disposed of in accordance with applicable federal and state requirements.
Facility Chamber shall be inspected for cracks or damage during each inspection. • Cleanout shall be done in a manner to minimize the amount of trapped oil entering the outlet pipe. If there is a valve on the outlet pipe it shall be closed otherwise the outlet will be plugged prior to cleanout. • Water and oil shall be removed, tested, and disposed of in accordance with regulations. Grit and sediment that has settled to the bottom of the chamber shall be removed during each cleaning • Cleaning shall be done without use of detergents or surfactants. A pressure washer may be used if necessary.
Absorbent Pillows and Pads (where applicable) absorb oil from the separation chamber. • Replacement shall occur at least twice a year, in the spring and fall, or as necessary to retain oil-absorbing function.
Outlet Pipe shall be inspected for clogging or leaks where it exits the facility. Particular attention shall be paid to ensure that the joint where the tee joins the outlet pipe is water tight. • Debris/sediment that is found to clog the outlet shall be removed, tested, and disposed of in accordance with applicable federal and state requirements.
Vegetation such as trees should not be located in or around the pre-treatment facility because roots can penetrate the unit body, and leaves from deciduous trees and shrubs can increase the risk of clogging. • Large shrubs or trees that are likely to interfere with facility operation shall be identified at each inspection and removed.
Source Control measures typically include structural and non-structural controls. Non-structural controls can include street sweeping and other good house keeping practices. • Source control measures shall be inspected and maintained.
Spill Prevention measures shall be exercised when handling substances that contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.
Training and/or written guidance information for operating and maintaining swales shall be provided to all property owners and tenants within the Mill Creek Industrial Park. A copy of the O&M Plan shall be provided to all property owners and tenants.
Access to the swale shall be safe and efficient. Egress and ingress routes shall be maintained to design standards. Roadways shall be maintained to accommodate size and weight of vehicles, if applicable. • Obstacles preventing maintenance personnel and/or equipment access to the swale shall be removed. • Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.
Insects & Rodents shall not be harbored in the sand filter. Pest control measures shall be taken when insects/rodents are found to be present. • If sprays are considered, then a mosquito larvicide, such as Bacillus thurendensis can be applied only if absolutely necessary, and only by a licensed individual or contractor. • Holes in the ground located in and around the sand filter shall be filled.

Table 7.4: Recommended Operations and Maintenance for Detention Ponds For Flow Control
Detention Ponds are constructed ponds with temporary storage for the detention of large storm events. The stormwater is stored and released slowly over a matter of hours. All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability. These inspections shall occur, at a minimum, quarterly for the first 2 years from the date of installation, and 2 times per year thereafter, and within 48 hours after each major storm event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

Pond Inlet shall assure unrestricted stormwater flow to the pond.
• Inlet pipe shall be cleared when conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.
• Determine if pipe is in good condition:
  o If more than 1 inch of settlement, add fill material and compact soils.
  o If alignment is faulty, correct alignment.
  o If cracks or openings exist indicated by evidence of erosion at leaks, repair or replace pipe as needed.

Forebay traps coarse sediments, reduces incoming velocity, and distributes runoff evenly over the wet pond. A minimum 1-foot freeboard shall be maintained. • Sediment buildup exceeding 50% of the facility capacity shall be removed every 2-5 years, or sooner if performance is being affected.

Embankment, Dikes, Berms & Side Slopes retain water in the wet pond.
• Slopes shall be stabilized using appropriate erosion control measures when native soil is exposed or erosion channels are forming.
• Structural deficiencies shall be corrected upon discovery:
  o If cracks exist, repair or replace structure.
  o If erosion channels deeper than 2 inches exist, stabilize surface. Sources of erosion damage shall be identified and controlled.

Control Devices (e.g., weirs, baffles, orifices, etc.) shall direct and reduce flow velocity. Structural deficiencies shall be corrected upon discovery: • If cracks exist, repair or replace structure. • Control devices shall be cleared when 25% of the conveyance capacity is plugged.
Overflow Structure conveys flow exceeding reservoir capacity to an approved stormwater receiving system. • Overflow structure shall be cleared when 50% of the conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected. • Sources of erosion damage shall be identified and controlled when native soil is exposed at the top of overflow structure or erosion channels are forming. • Rocks or other armoring shall be replaced when only one layer of rock exists above native soil.
Sediment & Debris Management shall prevent loss of pond storage volume caused by sedimentation. • Ponds shall be dredged when 1 foot of sediment accumulates in the pond bottom. • Gauges located at the opposite ends of the wet pond shall be maintained to monitor sedimentation. Gauges shall be checked 2 times per year.

- Sources of restricted sediment or debris, such as discarded lawn clippings, shall be identified and prevented.
- Debris in quantities sufficient to inhibit operation shall be removed routinely, e.g. no less than quarterly, or upon discovery.

Vegetation shall be healthy and dense enough to provide filtering while protecting underlying soils from erosion and minimizing solar exposure of open water areas.

- Mulch shall be replenished as needed to ensure survival of vegetation.
- Vegetation, large shrubs or trees that interfere with pond operation shall be pruned or removed.
- Fallen leaves and debris from deciduous plant foliage shall be removed if necessary.
- Nuisance and vegetation prohibited from the Pre-Approved Plant List (such as blackberries and English Ivy) shall be removed when discovered. Invasive vegetation contributing up to 25% of vegetation of all species shall be removed and replaced.
- Dead vegetation and woody material shall be removed to maintain less than 10% of area coverage or when pond function is impaired. Vegetation shall be replaced within 3 months, or immediately if required to maintain cover density and control erosion where soils are exposed.

Spill Prevention measures shall be exercised when handling substances that contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.

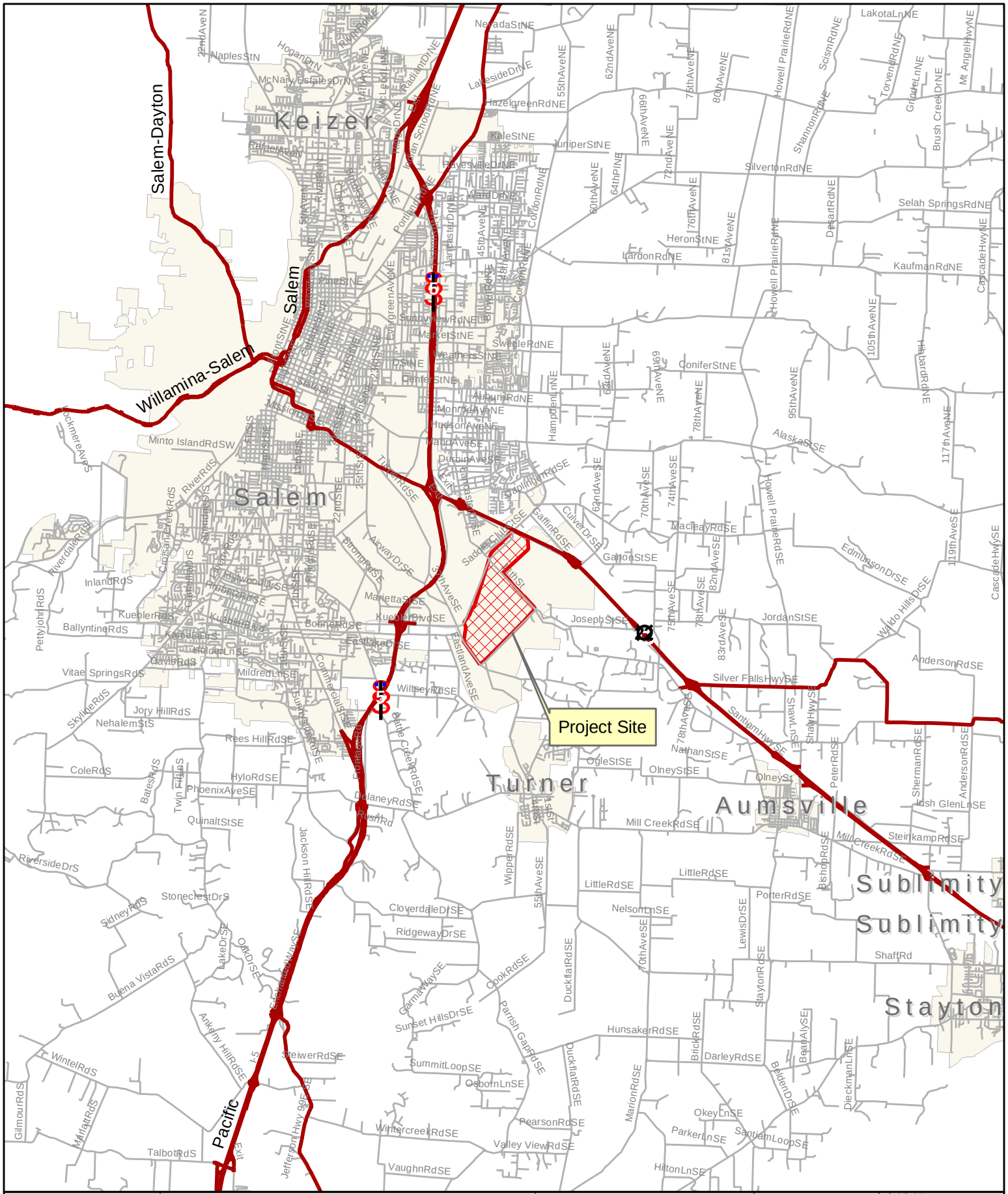
Training and/or written guidance information for operating and maintaining swales shall be provided to all property owners and tenants within the Mill Creek Industrial Park. A copy of the O&M Plan shall be provided to all property owners and tenants.

Access to the swale shall be safe and efficient. Egress and ingress routes shall be maintained to design standards. Roadways shall be maintained to accommodate size and weight of vehicles, if applicable.

- Obstacles preventing maintenance personnel and/or equipment access to the swale shall be removed.
- Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.

Insects & Rodents shall not be harbored in the sand filter. Pest control measures shall be taken when insects/rodents are found to be present.

- If sprays are considered, then a mosquito larvicide, such as Bacillus thurendensis can be applied only if absolutely necessary, and only by a licensed individual or contractor.
- Holes in the ground located in and around the sand filter shall be filled.



CITY OF Salem AT YOUR SERVICE
555 Liberty St SE
Salem, OR 97301

M.C.I.P. Master Plan

City of Salem Marion County, Oregon

Vicinity Map

otak
17355 SW Boones Ferry Road
Lake Oswego, Oregon 97035
Phone: (503) 635-3618
Fax: (503) 635-5395

Otak Proj. No.
12155

Date
February 15, 2006

Figure 1

Mill Creek Industrial Park

ASSUMED MASTER PLAN CONCEPT
FOR SURFACE WATER INFRASTRUCTURE PLAN
Otak Project No. 12155
February 15, 2006

Phase IB
146.1 Acres
Industrial, Large User
(Warehouse and Distribution)
Single Parcel

Phase IC
51.2 Acres
Industrial, 10-20 Acre Parcels
Includes Prison Employment

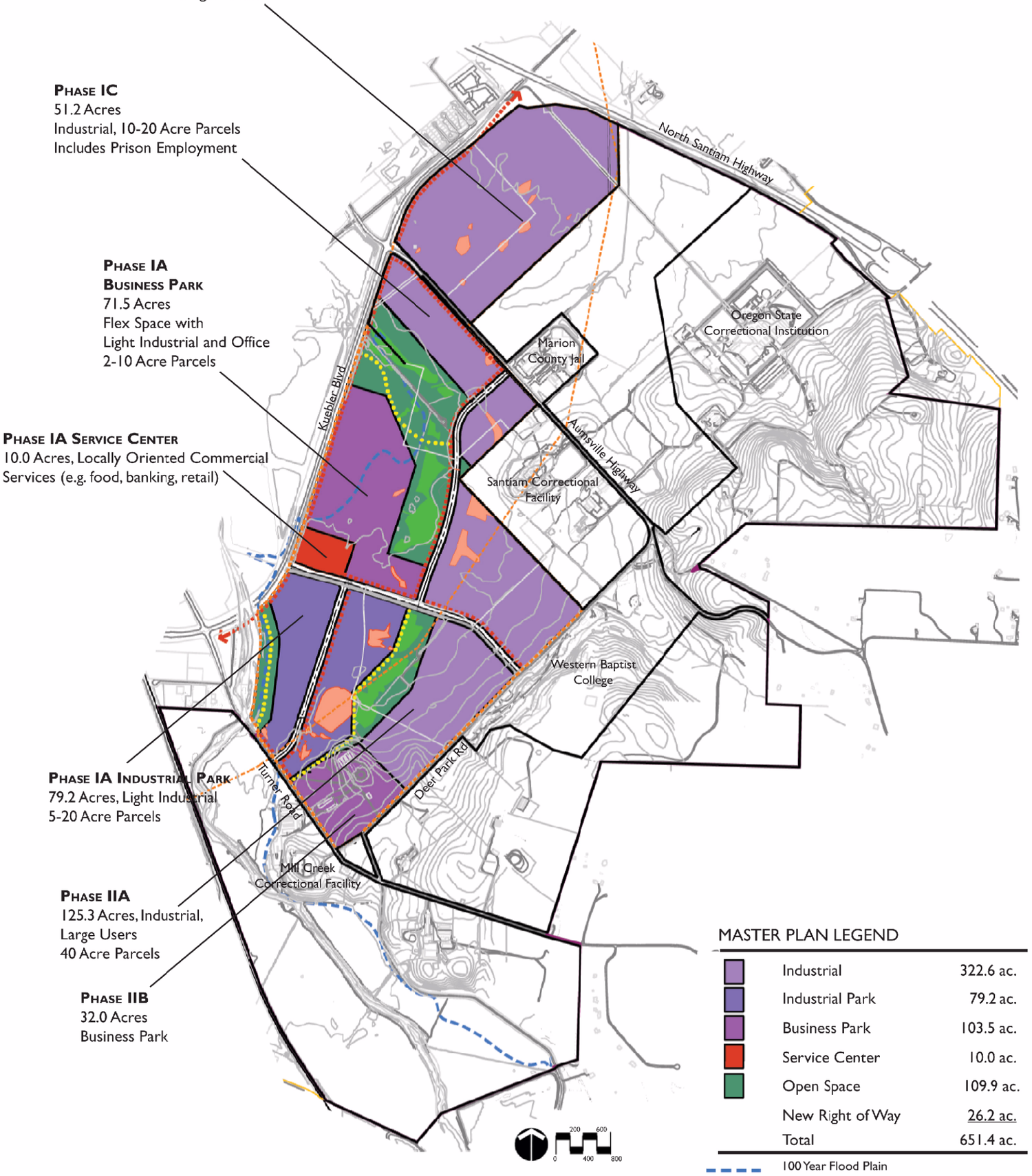
Phase IA
Business Park
71.5 Acres
Flex Space with
Light Industrial and Office
2-10 Acre Parcels

Phase IA Service Center
10.0 Acres, Locally Oriented Commercial
Services (e.g. food, banking, retail)

Phase IA Industrial Park
79.2 Acres, Light Industrial
5-20 Acre Parcels

Phase IIA
125.3 Acres, Industrial,
Large Users
40 Acre Parcels

Phase IIB
32.0 Acres
Business Park



MASTER PLAN LEGEND

	Industrial	322.6 ac.
	Industrial Park	79.2 ac.
	Business Park	103.5 ac.
	Service Center	10.0 ac.
	Open Space	109.9 ac.
	New Right of Way	26.2 ac.
	Total	651.4 ac.

100 Year Flood Plain
10,000' Airport Buffer
Multi-Use Path in Right-of-Way
Recreational Trail
Existing Protected Wetlands
Potential Wetland Impact Areas to be Mitigated

Note: Parcel areas are preliminary and subject to change.

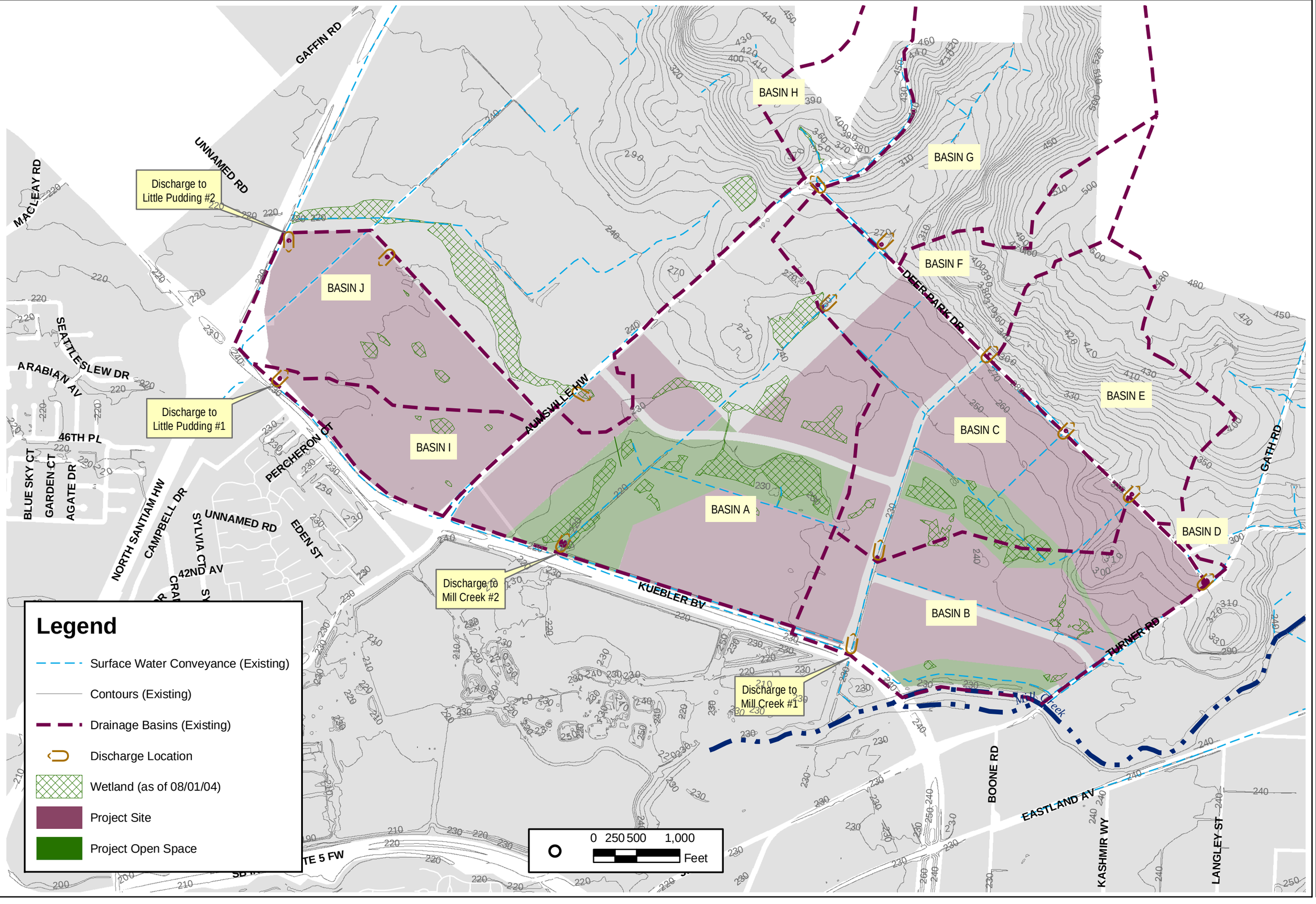
otak

STATE OF OREGON 1859

CITY OF Salem AT YOUR SERVICE

Figure 2

A Collaboration between the State of Oregon and City of Salem



February 15, 2006
Date
KJT
Designed
KJT
Drawn
Checked by Date

CITY OF Salem AT YOUR SERVICE
555 Liberty St SE
Salem, OR 97301

Mill Creek Industrial Park Master Plan

City of Salem Marion County, Oregon

SURFACE WATER MANAGEMENT
EXISTING DRAINAGE BASINS MAP

otak
17355 SW Boones Ferry Road
Lake Oswego, Oregon 97035
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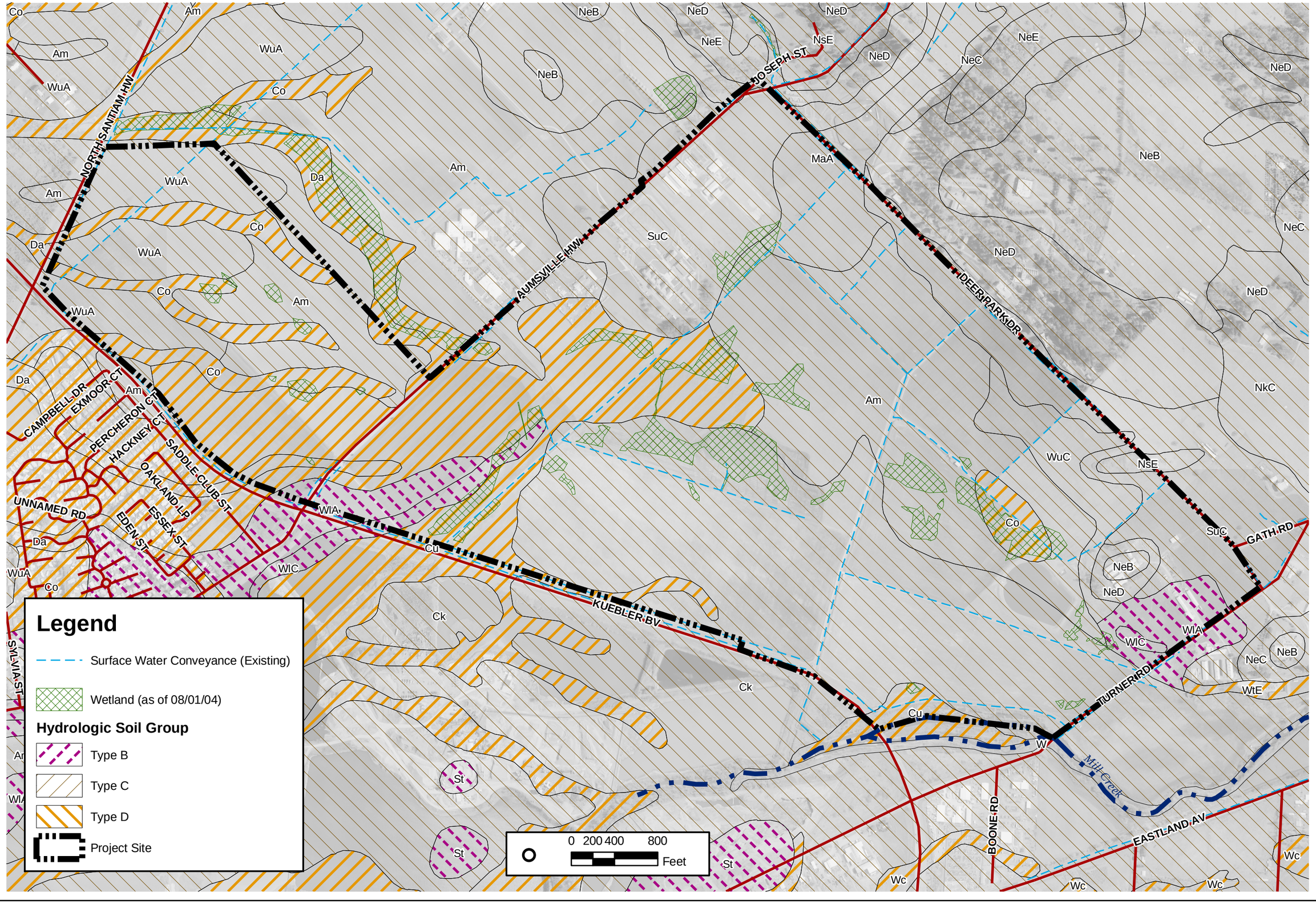
12155
Project No.

Figure 3
Sheet No.



February 15, 2006

Date

Designed KJT/GF

Drawn

Checked by Date

CITY OF Salem AT YOUR SERVICE

555 Liberty St SE
Salem, OR 97301

Mill Creek Industrial Park Master Plan

City of Salem Marion County, Oregon

SURFACE WATER MANAGEMENT
NRCS SOILS SURVEY MAP

otak

17355 SW Boones Ferry Road
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12155
Project No.

Figure 4
Sheet No.

DRAFT

UNNAMED RD
NORTH SANTIAM HWY
AUMSVILLE HWY
CAMPBELL DR
SADDLE CLUB
UNNAMED RD
KUEBLER BV
DEER PARK DR
GATH RD
TURNER RD
EASTLAND AV
BOONE RD

48" STORM PIPE
60" CULVERT
48" STORM PIPE
24" STORM PIPE
CENTRAL OPEN SPACE
IE=215.95
72" CULVERT
IE=215.60
FLOOD OVERFLOW CHANNEL
60" STORM PIPE
48" STORM PIPE
24" STORM PIPE
12" STORM PIPE
36" STORM PIPE
FLOW SPLITTER
24" STORM PIPE
18" STORM PIPE
48" OVERFLOW STORM PIPE
EXISTING OPEN CHANNEL
SOUTH OPEN SPACE
24" STORM PIPE
18" STORM PIPE
IE=226.57
18" STORM PIPE
24" STORM PIPE
Mill Creek

0 200 400 800
Feet

Legend

- Project Site
- Project Open Space
- Wetland (as of 08/01/04)
- Surface Water Conveyance (Existing)
- Contours (Existing)

Surface Water Management (Proposed)

- Detention Storage Grading Contours
- Open Channel Conveyance
- Storm Pipe
- Vegetated Treatment/Conveyance Swale

February 15, 2006
Date
KJT
Designed
KJT
Drawn
Checked by Date

CITY OF Salem AT YOUR SERVICE
555 Liberty St SE
Salem, OR 97301

Mill Creek Industrial Park Master Plan

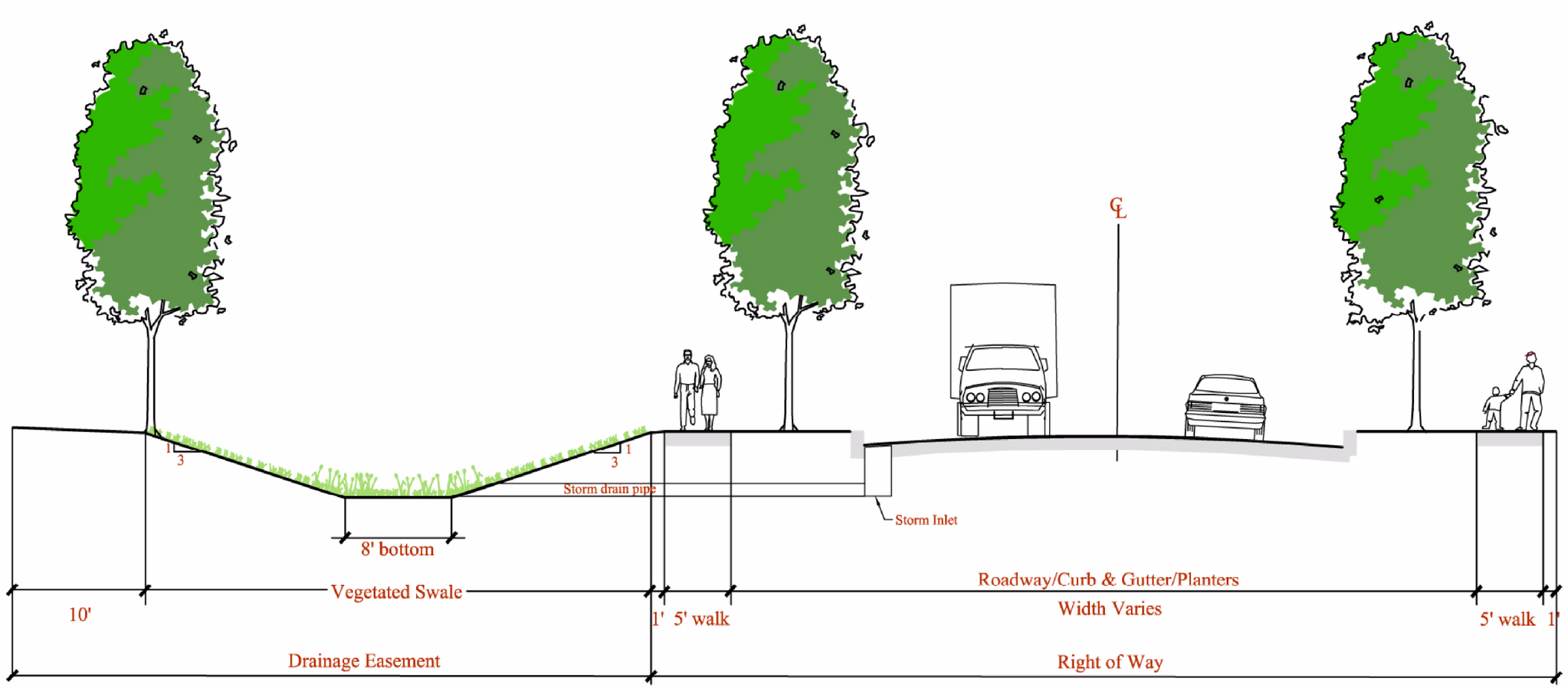
City of Salem
Marion County, Oregon

SURFACE WATER MANAGEMENT
INFRASTRUCTURE MAP

otak
17355 SW Boones Ferry Road
Lake Oswego, Oregon 97035
Phone: (503) 635-3618
Fax: (503) 635-5395

12155
Project No.

Figure 5
Sheet No.



Right of Way Cross-Section

AUMSVILLE HWY.

PRELIMINARY

February 15, 2006
Date
KJT
Designed
KJT
Drawn
Checked by Date

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Mill Creek Industrial Park Master Plan
City of Salem Marion County, Oregon
RIGHT-OF-WAY CROSS-SECTION
CONCEPTUAL ILLUSTRATION - AUMSVILLE HWY.

otak
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Lake Oswego, Oregon 97035
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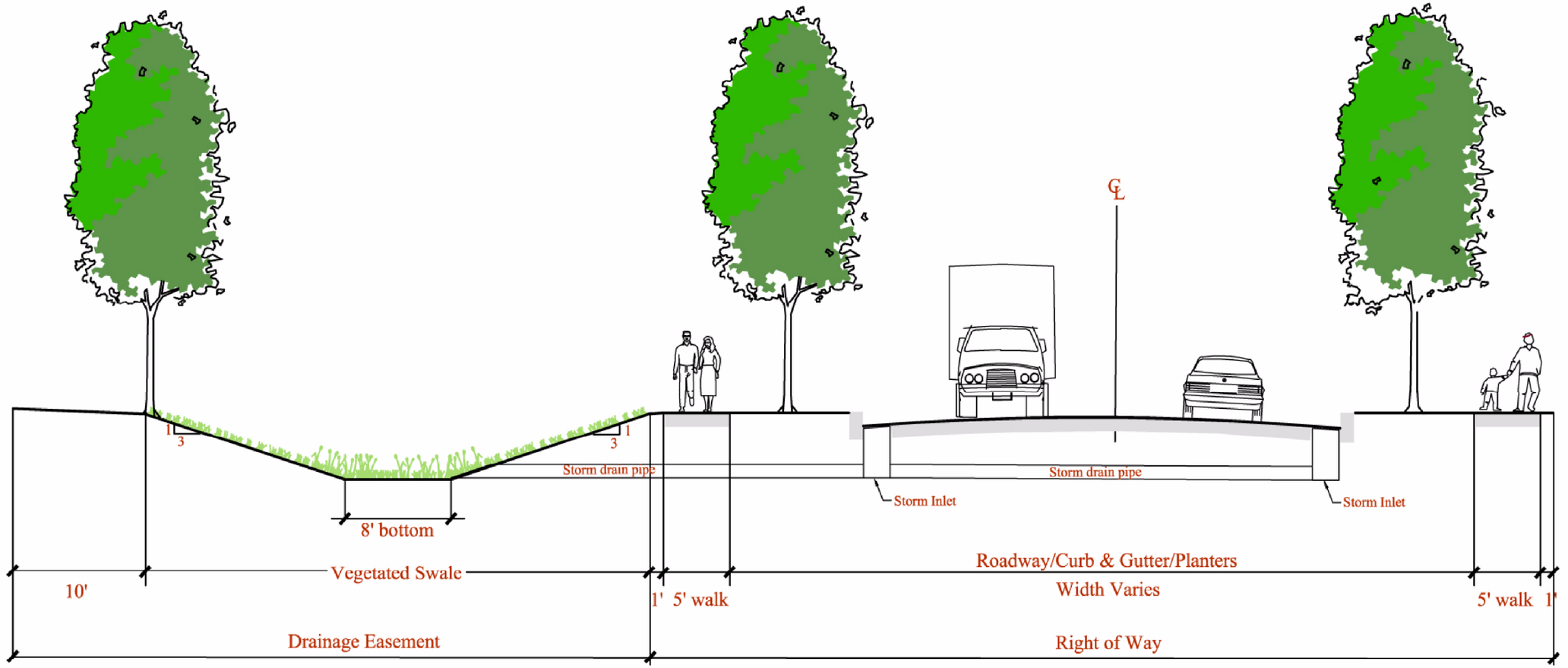
Fax: (503) 635-5395

12155
Project No.
Figure 6A
Sheet No.



Right of Way Cross-Section

NEW NORTH-SOUTH RD.

PRELIMINARY

February 15, 2006
Date
KJT
Designed
KJT
Drawn
Checked by Date

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Mill Creek Industrial Park Master Plan
City of Salem Marion County, Oregon
RIGHT-OF-WAY CROSS-SECTION
CONCEPTUAL ILLUSTRATION - NEW NORTH-SOUTH RD.

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Lake Oswego, Oregon 97035
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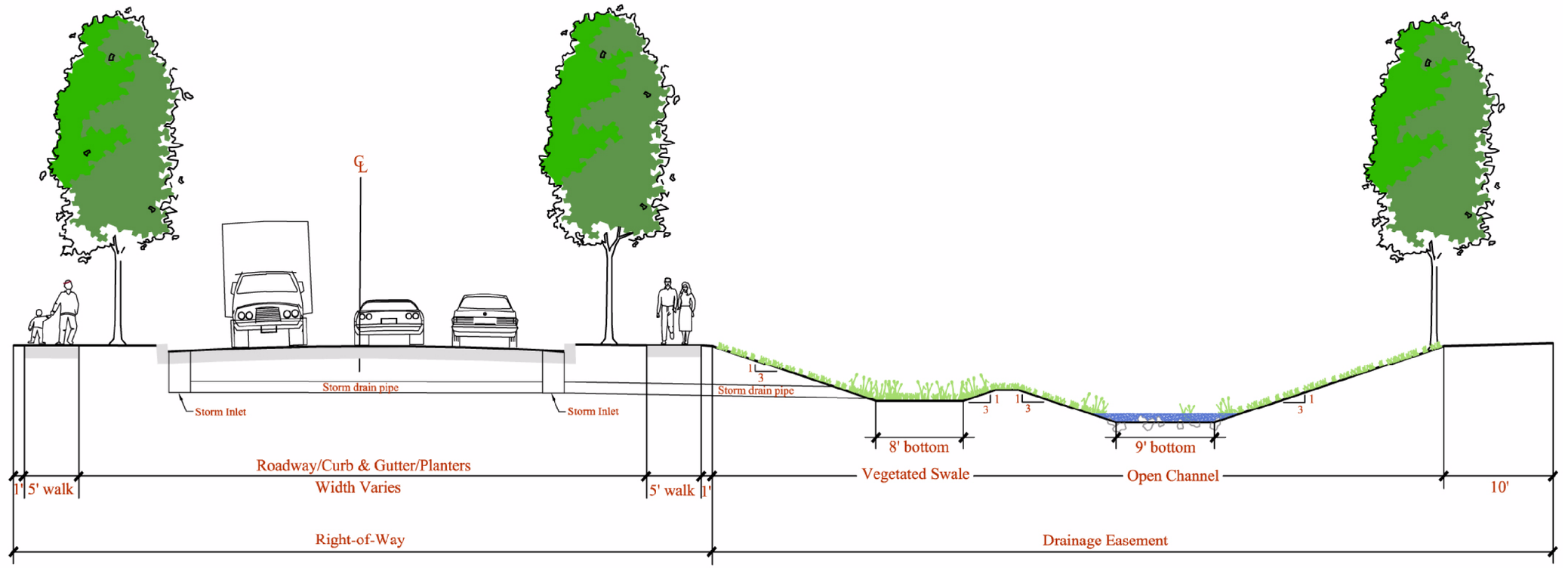
12155
Project No.
Figure 6B
Sheet No.



Right of Way Cross-Section

NEW EAST-WEST RD.

PRELIMINARY

February 15, 2006
Date
KJT
Designed
KJT
Drawn
Checked by Date

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Mill Creek Industrial Park Master Plan
City of Salem Marion County, Oregon
RIGHT-OF-WAY CROSS-SECTION
CONCEPTUAL ILLUSTRATION - NEW EAST-WEST RD.

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Lake Oswego, Oregon 97035
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Project No.
Figure 6C
Sheet No.

Legend

- Project Site
- Project Open Space
- Wetland (as of 08/01/04)
- Surface Water Conveyance (Existing)
- Contours (Existing)

Surface Water Management (Proposed)

- Detention Storage Grading Contours
- Open Channel Conveyance
- Storm Pipe
- Vegetated Treatment/Conveyance Swale
- Drainage Basins (Proposed)
- Possible Subbasins
- basin-proposed

BASIN H
BASIN G
BASIN F
BASIN J
BASIN I
BASIN A
BASIN C
BASIN E
BASIN D
BASIN B

Discharge to Little Pudding #2
Discharge to Little Pudding #1
Discharge to Mill Creek #2
Discharge to Mill Creek #1

GAFFIN RD
UNNAMED RD
JOSEPH ST
DEER PARK DR
ALMSTEAD HW
PERCHERON CT
SADDLE CLUB ST
KUEBLER BV
TURNER RD
GATH RD
49TH AV
ARABIAN AV
SEATTLE SLEW DR
46TH PL
GROUSE DR
ARABIAN CT
BLUE SKY CT
AGATE DR
WILDCHERRY DR
NORTH SANTIAM HW
CAMPBELL DR
SYLVIA CT
SYLVIA ST
EDEN ST
CARSON DR
CRANSTON ST
RICKEY ST
40TH PL
Mill Creek

0 250 500 1,000 Feet

February 15, 2006
Date
KJT
Designed
KJT
Drawn
Checked by Date

CITY OF Salem AT YOUR SERVICE
555 Liberty St SE
Salem, OR 97301

Mill Creek Industrial Park Master Plan

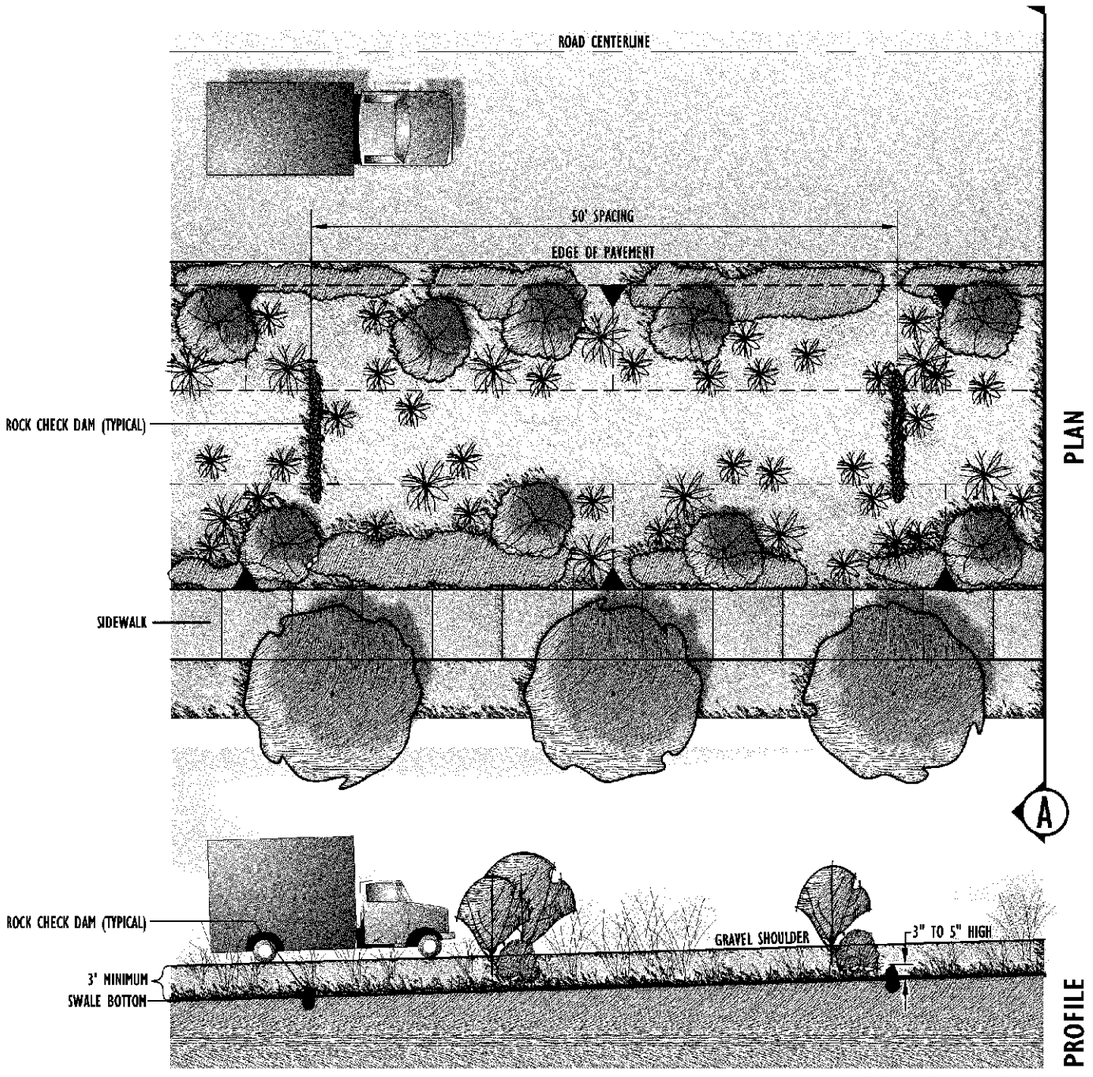
City of Salem — Marion County, Oregon

SURFACE WATER MANAGEMENT
DRAINAGE BASINS & POTENTIAL SUBBASINS

otak
17355 SW Boones Ferry Road
Lake Oswego, Oregon 97035
Phone: (503) 635-3618
Fax: (503) 635-5395

12155
Project No.

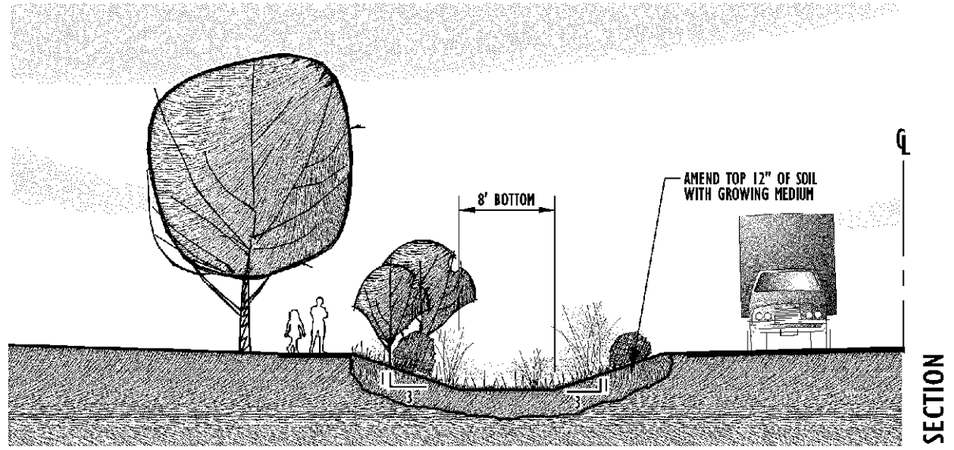
Figure 7
Sheet No.



SWALE BOTTOM SLOPE = 0.1% TO 0.5%

VEGETATED SWALE - TYPE 1

NOT TO SCALE



SWALE BOTTOM SLOPE = 0.1% TO 0.5%

TYPICAL VEGETATED SWALE

A

NOT TO SCALE

PRELIMINARY

February 15, 2006
Date
KJT
Designed
RH
Drawn
Checked by Date

CITY OF Salem AT YOUR SERVICE
555 Liberty St SE
Salem, OR 97301

Mill Creek Industrial Park Master Plan
City of Salem Marion County, Oregon
VEGETATED SWALE - TYPE 1
TYPICAL DETAILS

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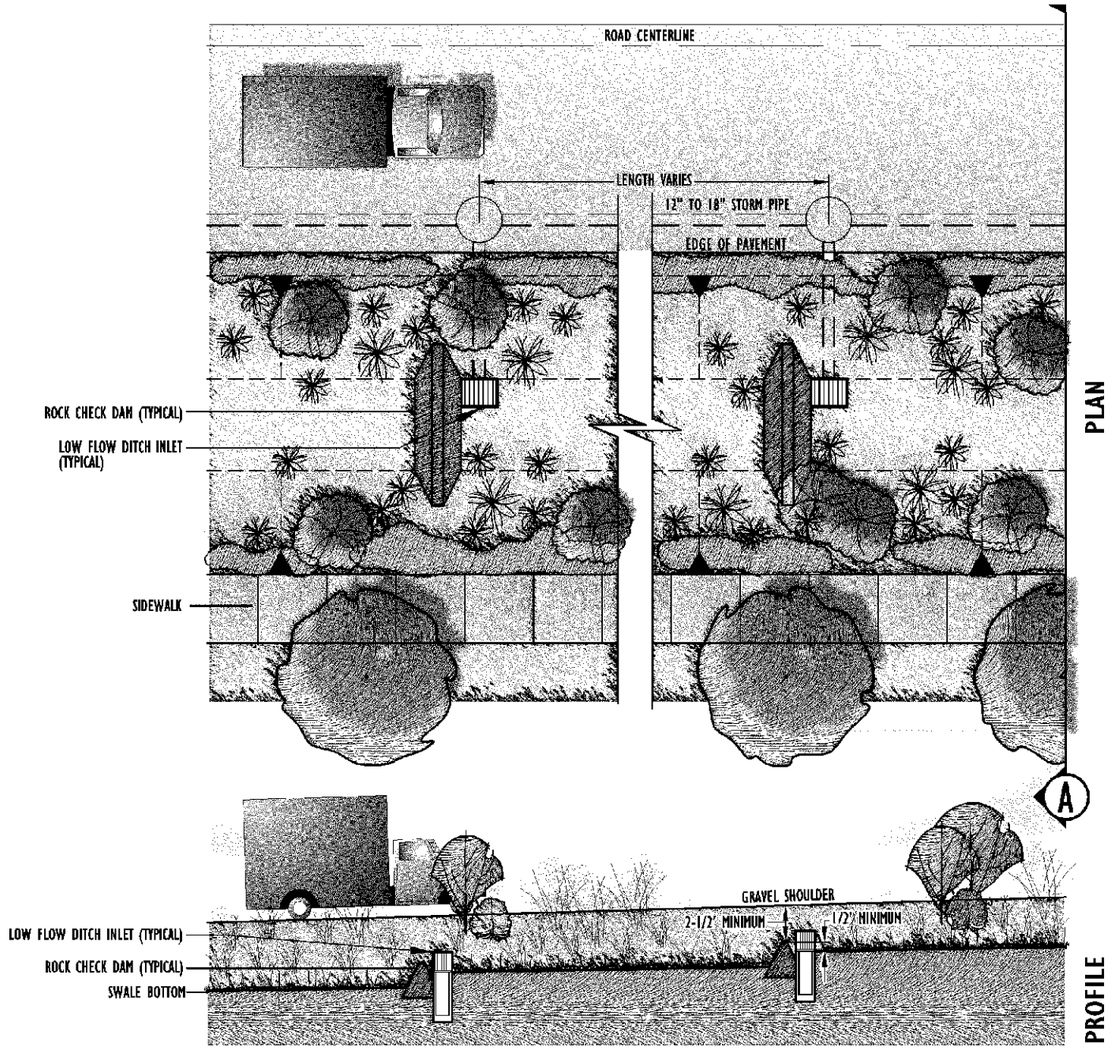
Lake Oswego, Oregon 97035
Phone: (503) 635-3618
Fax: (503) 635-5395

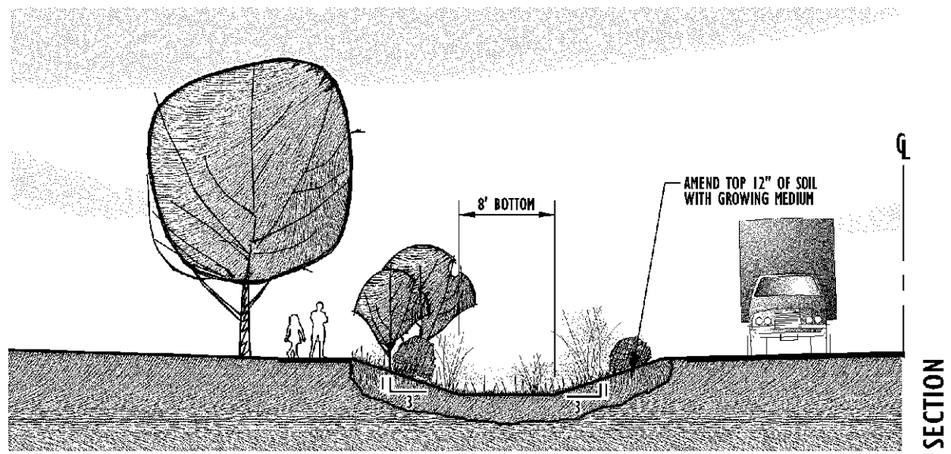
12155
Project No.
Figure 8
Sheet No.



SWALE BOTTOM SLOPE = 0.1% TO 0.5%

VEGETATED SWALE - TYPE 2

NOT TO SCALE



SWALE BOTTOM SLOPE = 0.1% TO 0.5%

A TYPICAL VEGETATED SWALE

NOT TO SCALE

PRELIMINARY

February 15, 2006

Date

KJT

Designed

RH

Drawn

Checked by Date

CITY OF Salem AT YOUR SERVICE
555 Liberty St SE
Salem, OR 97301

Mill Creek Industrial Park Master Plan

City of Salem Marion County, Oregon

VEGETATED SWALE - TYPE 2
TYPICAL DETAILS

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12155

Project No.

Figure 9

Sheet No.

Legend

- Project Site
- Project Open Space
- Wetland (as of 08/01/04)
- DPSST Site
- Surface Water Conveyance (Existing)
- Contours (Existing 10 ft.)
- Contours (Existing 2 ft.)

Surface Water Management (Proposed)

- Storm Pipe
- Vegetated Treatment/Conveyance Swale
- Drainage Basins (Proposed)
- Possible Subbasins
- Discharge Location

Discharge to Little Pudding #2

Discharge to DPSST Detention Pond

Discharge to Little Pudding #1

BASIN J

BASIN I

SEATTLE SLEW DR

SECRETARIAT DR

ARABIAN AV

46TH PL

WILDCHERRY DR

NORTH SANTIAM HWY

CAMPBELL DR

UNNAMED RD

SADDLE CLUB ST

KUEBLER BV

AUMSVILLE HWY

OAKLAND LP

0 100 200 400 Feet

August 2005
Date
KJT
Designed
KJT
Drawn
Checked by Date

CITY OF Salem AT YOUR SERVICE
555 Liberty St SE
Salem, OR 97301

Mill Creek Industrial Park (formerly Salem Regional Employment Center)

City of Salem — Marion County, Oregon

SURFACE WATER MANAGEMENT
PHASE IB PARCEL

otak
17355 SW Boones Ferry Road
Lake Oswego, Oregon 97035
Phone: (503) 635-3618
Fax: (503) 635-5395

12155
Project No.

Figure 10
Sheet No.