PHYTOREMEDIATION PLAN

WM RICHMOND LANDFILL
TOWN OF GREATER NAPANEE, ONTARIO

WESA

Prepared For:

WASTE MANAGEMENT OF CANADA CORPORATION
1271 Beechwood Road, R.R. #6
Napanee, Ontario K7R 3L1

December 2010

WESA
A Better Environment For Business

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1.0 INTRODUCTION AND RATIONALE

Waste Management of Canada Corporation (WM) owns and operates the WM Richmond Landfill, located on Part of Lots 1, 2 and 3, Concession IV, of the former Township of Richmond now in the Town of Greater Napanee (see location on Figure 1). The company holds a Provisional Certificate of Approval for a Waste Disposal Site, which permits the use of a 16.2 hectare landfill within a total site area of 138 hectares. The current Certificate of Approval No. A371202, Notice No. 5, was issued on March 31, 2010.

WM is developing a phytoremediation system adjacent to the northwest corner of the landfill footprint. As described below, the system is a passive operation; that is, it will not be irrigated with leachate as is commonly done at landfill sites using phytoremediation for leachate treatment. Instead, the system will make use of the natural ability of selected trees and shrubs to take up large amounts of shallow groundwater, effectively controlling the migration of low concentrations of dissolved solutes identified in groundwater.

Phytoremediation is the use of plants to contain, remove or degrade contaminants in soil and water. Biological uptake and contaminant degradation by plants are dependent on rhizosphere processes and the microbial communities that develop and grow within the root zone. Both non-woody (grasses, aquatic vegetation, etc.) and woody (trees and shrubs) species have been shown to be effective in the remediation of organic compounds, metals, nutrients and other contaminants. In particular, trees such as poplars and willows can take up significant quantities of groundwater. This tends to depress the water table under intensively-cultured plantations, which creates a zone of hydraulic capture. Roots from such hydrophyllic species can extend to depths of 3 to 5 metres or more to obtain water and nutrients. Shrubs such as dogwoods are also used in the stabilization of channel banks and removal of suspended solids and nutrients from stormwater.

WM uses phytoremediation processes for leachate treatment at several sites in Canada and the US, including the Riverbend Landfill in Oregon, and the Twin Creeks, Blenheim, Petrolia, LaSalle and Ottawa Landfills in Ontario. Hybrid poplars and willows are generally used at these sites, and leachate is usually drip-irrigated onto the ground beside the plants. The plants take up the moisture, and in so doing, remediate contaminants in the leachate. The strength of leachate used in the operations varies from a dilute mixture with water in young plantations to full-strength leachate for mature trees.

In contrast, the phytoremediation system at the WM Richmond Landfill will not be irrigated and will rely solely on precipitation and shallow groundwater for moisture. The intent is to use the plants' abilities to take up shallow groundwater and control the migration of low concentrations of dissolved constituents downgradient from the landfill.

Groundwater in some of the monitoring wells located within the proposed plantation area and adjacent to the landfill footprint exhibits concentrations of some leachate indicators, such as COD, DOC, chloride, sodium, iron, etc. that are elevated relative to background concentrations. The observed groundwater concentrations downgradient from the landfill are consistent with the predicted transport derived from numerical modeling, which indicated that shallow groundwater impacted with leachate could have migrated approximately 40 metres from the toe of the northwest corner of the landfill. Passive phytoremediation will be used as a means of mitigating further transport of dissolved constituents from the landfill.

It is important to note that there are no off-site groundwater or surface water impacts that have been identified arising from the observed concentrations northwest of the landfill. In other words, there has been no detection of groundwater or surface water impacts at the property boundary, which is the point of compliance for the Site. The phytoremediation system presented herein will address on a proactive basis, the identified impact, prior to any site compliance issue arising.

Condition 140 of Certificate of Approval No. A371202, Notice No. 5, stipulates that:

"Prior to the start of construction of the phytoremediation system proposed for the northwest corner of the Site, the Owner shall submit for approval to the Director, details on the proposed phytoremediation system."

The purpose of this document is to provide the details of the phytoremediation system as required by Condition 140. A description of the phytoremediation area, shallow groundwater conditions, tree/shrub species and planting layout, maintenance procedures and monitoring program are presented in this document.

2.0 DESCRIPTION OF PHYTOREMEDIATION AREA

The area designed for the passive phytoremediation system is located adjacent to the northwest corner of the existing landfill footprint (refer to Figure 2 for an aerial photograph view and Figure 3 for a site plan showing ground contours and site features). The area is approximately 3.65 hectares (9.0 acres) in size and is defined by the identified presence of elevated constituent concentrations observed as a result of the routine groundwater monitoring program at the Site. The majority of the planting area is located within the Lennox-Oshawa Hydro Corridor, as shown on Figures 2 and 3. Hydro One has been consulted in the development of this plan to determine the various types of tree or shrub species that are

acceptable for planting. To avoid interference with the overhead high voltage transmission lines, any plantings within the transmission corridor must use trees or shrubs that can be maintained below a total height of 3.66 metres (12 feet) above the ground surface.

The phytoremediation area extends approximately 150 metres west and 70 metres north of the landfill footprint. The distance from the western edge of the phytoremediation area to the WM property line along County Road 10 is approximately 200 metres, and from the northern edge of the phytoremediation area to Marysville Creek ranges from approximately 40 to 100 metres.

The planting area is underlain by a clayey silt till that varies in thickness from approximately 1.5 to 3.7 metres. The upper stratum of bedrock underlying the overburden consists of the Verulam Formation, which is an interbedded limestone and shale. Observations from trench excavations at the site indicate that the bedrock surface is generally competent and only occasionally fractured. Based on water level measurements taken in monitoring wells within the area, the shallow groundwater level appears to vary from approximately 0.5 to 3.0 metres below ground surface, depending on monitoring well location and the season. Shallow groundwater flownets prepared from water level measurements in the Spring and Fall 2009 are shown on Figure 4. The interpreted flow directions in the shallow groundwater zone are to the north and northwest, away from the landfill footprint toward a low head area where Marysville Creek intersects County Road 10. Therefore, the planting area is situated downgradient from the northwest corner of the landfill footprint, between the landfill and the low head area.

3.0 SELECTED SPECIES AND PROPOSED PLANTING LAYOUT

A summary of the tree and shrub species selected for planting and the rationale for their use is provided in Table 1. The species have been selected based on their known ability to take up large amounts of water for growth, tolerance for areas with high water levels, phytoremediation capabilities, and based on the height restrictions for plantings within the hydro transmission corridor. For example, shrub willows have a high water demand and can easily be maintained below a height of 3.7 metres (12 feet). Evapotranspiration studies on shrub willow plantations have shown transpiration rates of 100,000 litres/day per hectare at full canopy closure during the warmest and driest summer months.

Table 1: Summary of Plant Species

Common Name	Species/Clone Name	Rationale for Use
Purple osier willow	Hotel willow	Rapid growth, 3.5 metre maximum height for use under hydro lines, excellent survival in moist to wet growing medium. Ability to uptake heavy metals such as zinc, cadmium and lead.
Salix spp. (no known common name)	Alpha Willow	Rapid growth, 3.5 metre maximum height for use under hydro lines, excellent survival in moist to wet growing medium. Ability to uptake heavy metals such as zinc, cadmium and lead.
Red osier dogwood	Cornus sericea	Excellent survival in moist to wet growing medium, good wildlife benefits, maximum height 3 metres, has successfully been mixed with willow shrubs in bioengineering practices.
Silky dogwood	Cornus amomum	Excellent survival in moist to wet growing medium, good wildlife benefits, maximum height 3 metres, can be mixed with other shrubs for species diversity

The vegetation will be planted using either cuttings (e.g., willows) or rooted plants (dogwoods). Multiple species and clones will be planted to reduce the potential impact from diseases affecting monocultures, and to provide diversity for natural habitat. The conceptual plantation layout is illustrated on Figure 5. This will be adjusted if necessary to suit field conditions.

The spacing between planting rows will be approximately 2.5 metres to allow sufficient space for mowing and maintenance. The spacing between plants within an individual row will be dependent on the species. For example, willows will be planted approximately 1.75 metres apart; the dogwoods will be planted approximately 1.5 metres apart. Willows and dogwoods will not be intermixed within rows. Alternating rows of willows and dogwoods will vary such that a total of approximately 25% of dogwoods will be alternated with a total of approximately 75% willows. The larger multiple rows of willows will be concentrated closer to the landfill footprint for maximum water uptake. Any trees or shrubs that do not survive will be replaced once within the first two years to ensure adequate coverage within the phytoremediation area.

Prior to planting, the ground within the plantation area will be prepared by discing and harrowing or tilling to remove the existing vegetation and to produce a smooth planting bed.

4.0 INSPECTION AND MAINTENANCE PROCEDURES

The phytoremediation system is planned as a passive operation that will not require frequent inspection or interface. However, routine seasonal and annual maintenance procedures will be adopted to ensure the health of the plantation. These will include the following:

Quarterly (seasonal):

- Inspect the tree and shrub plantings for evidence of disease, insect or rodent damage, leaf necrosis, general plant vigour and plantation conditions;
- Note the height and diameter of selected trees and shrubs within the plantation;
- Inspect the vegetation between rows and assess the need for de-vegetation maintenance;

Annually (May to October):

- Infill rows where any trees or shrubs have died to maintain adequate spacing between individual plants;
- Prune any trees to maintain height restrictions or to promote growth;
- In the first two to three years, until the trees and shrubs become well established, apply herbicide up to a distance of 0.5 metres around the individual plant stems to remove competition from grasses and to prevent rodent infestations, as necessary;
- Mow vegetation between rows as needed for the first three years or until the shrubs obtain at least half their maximum height.

Once the plantation matures, for example after ten to fifteen years, a program of rotational harvesting will commence, with a proportion of the trees and shrubs harvested and re-planted each year. This will allow for a complete renewal of the plantation over time, while managing the removal of mature vegetation.

5.0 PROPOSED MONITORING PROGRAM

Groundwater and surface water monitoring will be conducted as documented in the Environmental Monitoring Plan (EMP) for the WM Richmond Landfill. The EMP includes monitoring of groundwater in the Shallow Zone and Intermediate Bedrock Zone in monitoring wells adjacent to the proposed plantation, including the following:

Shallow Zone

- **Water Levels** – M27, M29, M30, M31, M38, M66-2, M67-2, M100, M101, M102, M103.
- **Chemistry** – M29, M66-2, M67-2, M101, M102, M103.

Intermediate Bedrock Zone

- **Water Levels** – M3A-3, M5-3, M6-3, M74, M75.
- **Chemistry** – M5-3, M6-3, M74, M75.

These monitoring well locations are shown on Figure 3. Observations of groundwater elevations and groundwater chemistry are made on a semi-annual basis in accordance with the EMP. The data will be evaluated to observe whether there are discernable trends in flow or chemistry that can be attributed to the passive phytoremediation plantation.

Surface water samples are also collected on a semi-annual basis from Marysville Creek under the EMP. Since there is no impact from landfill activities on surface water quality in the creek, it is unlikely that any effects from the passive phytoremediation system will be observed.

LIST OF FIGURES

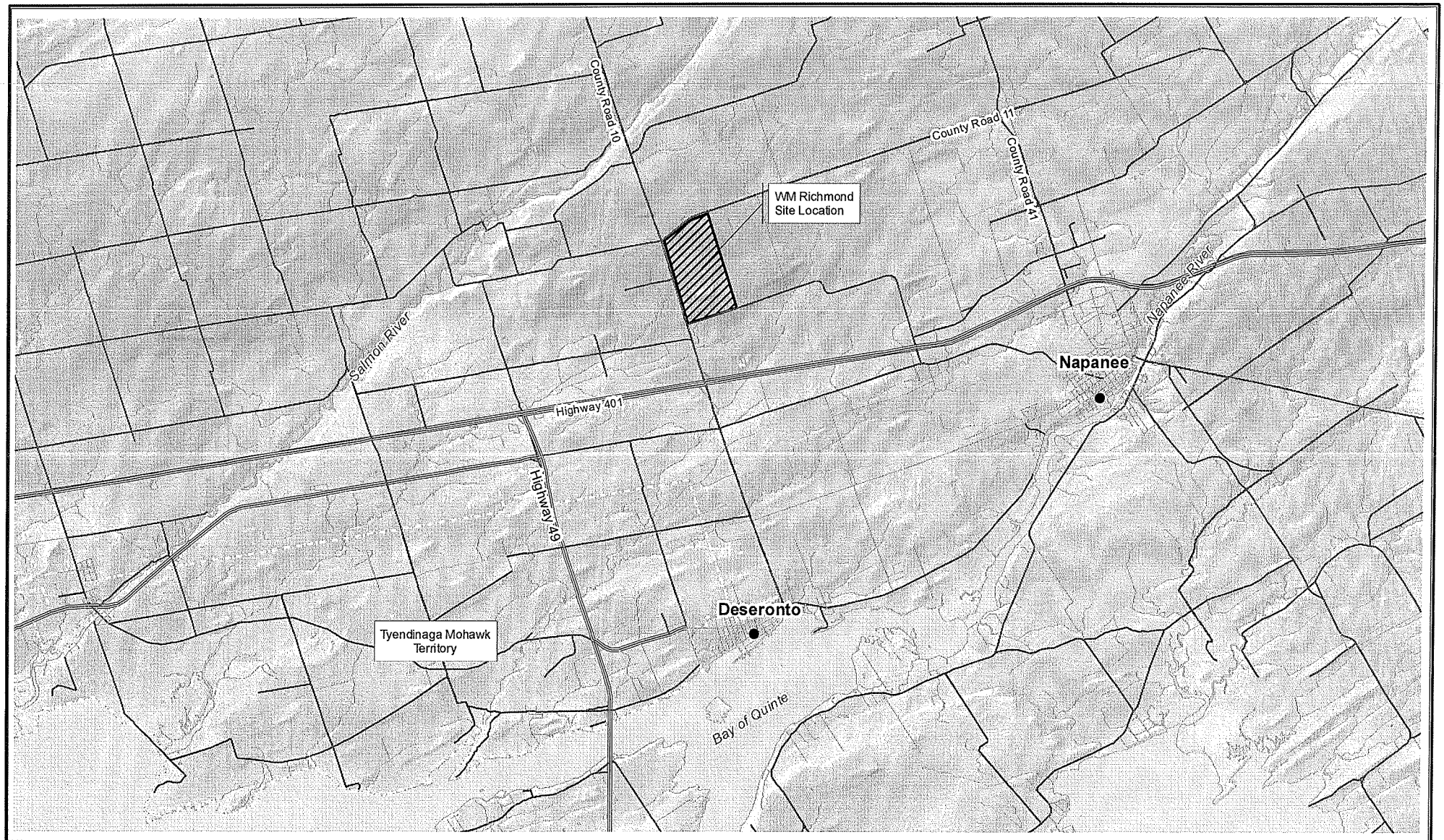

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Figure 1
Site Location Map

Site Location
Streams
Topography (m)
High : 180
Low : 50

Project : K-B8579-00-02
Data Source: WM Canada, WESA, HPA Ltd. Base Mapping
Date: November 2010

0.9 0.45 0 0.9
Kilometers

Prepared by:
WESA Geomatics

Units:
UTM NAD 83 Zone 18

Scale: 1:75000

WESA

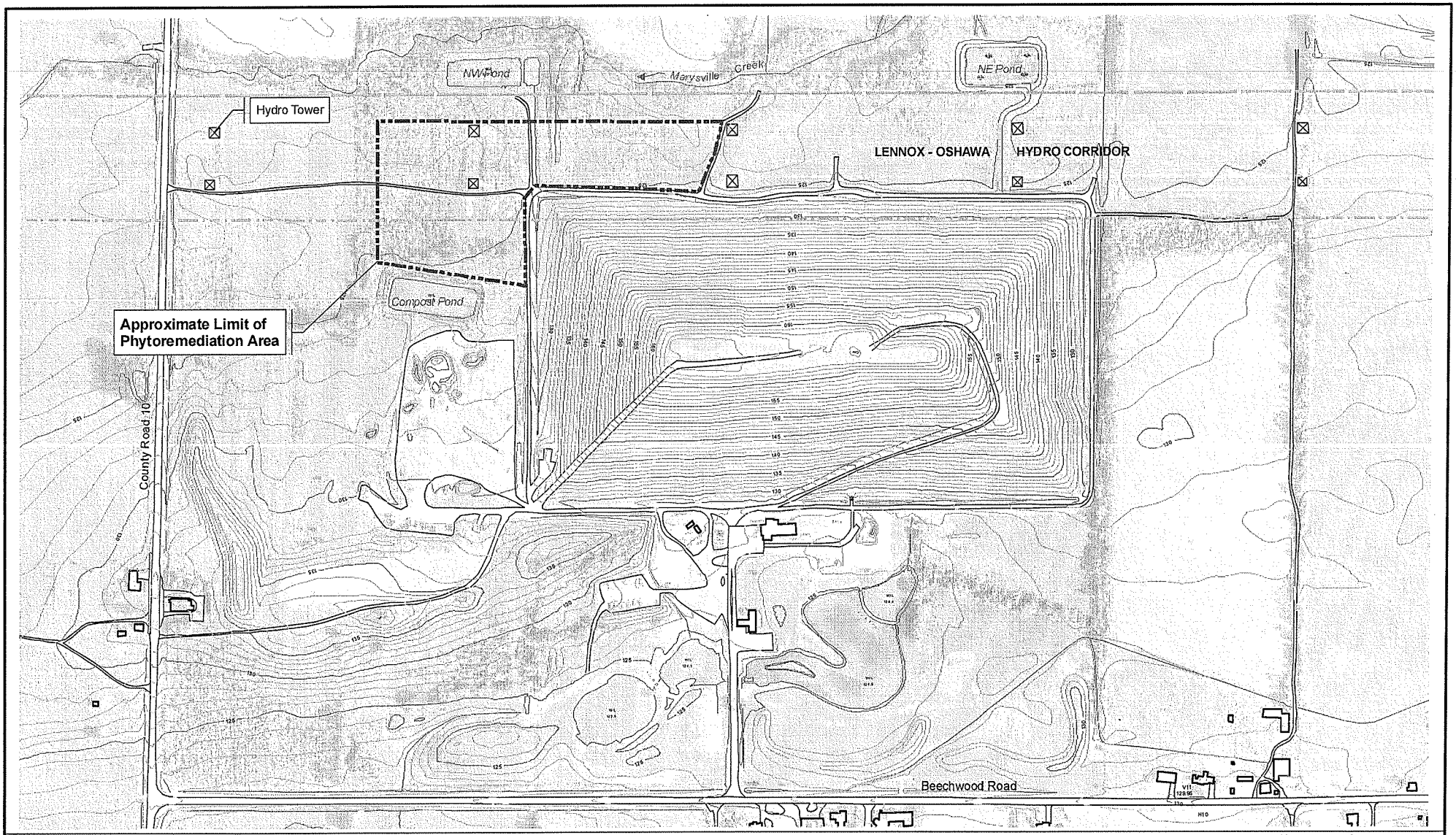

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Figure 2:
Aerial Photograph of Phytoremediation Area

Legend

Approximate Limit of Phytoremediation Area

Project: K-B8579-00-02
Data Source: WM Canada, WESA, HPA Ltd. Base Mapping(2009)
Date: November, 2010

Prepared by:
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Units: Metres
UTM NAD 83 Zone 18
Scale: 1:3500

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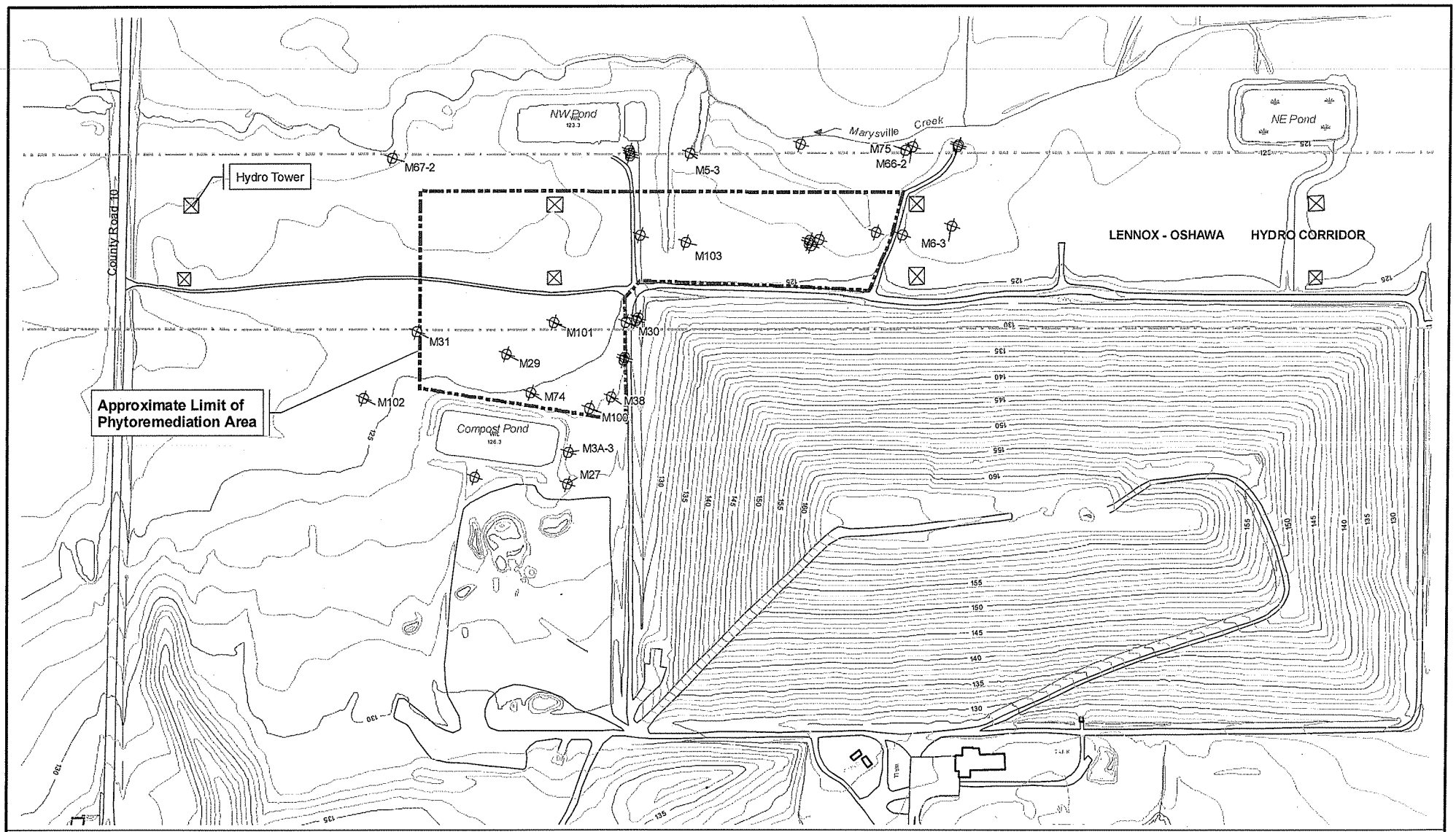

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Figure 3:
Site Plan of Phytoremediation Area

Legend

- Approximate Limit of Phytoremediation Area
- M52-2 Monitoring well listed in EMP
- Other monitoring wells in vicinity of phytoremediation area

Project: K-B8579-00-02
Data Source: WM Canada, WESA, HPA Ltd. Base Mapping(2009)
Date: November, 2010

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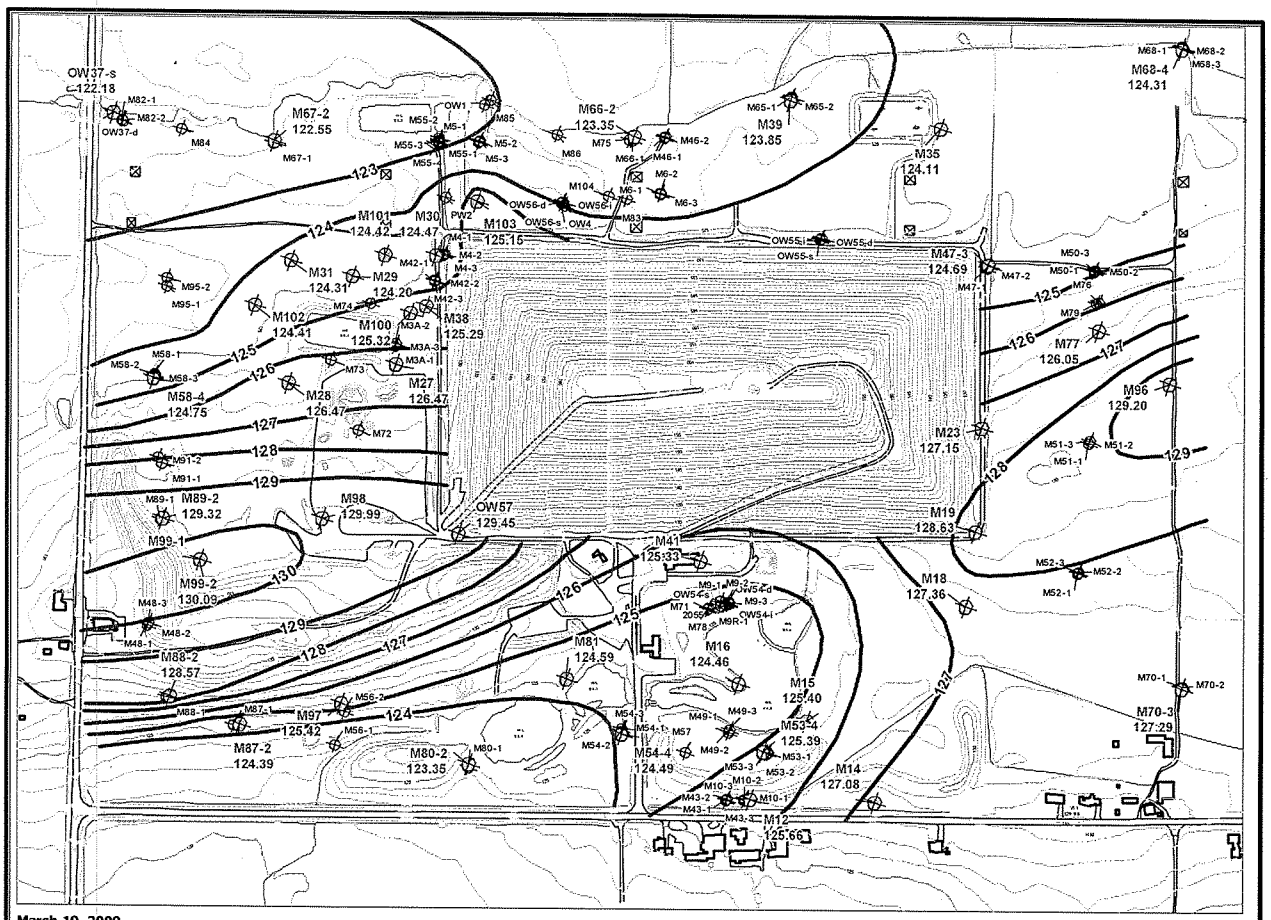
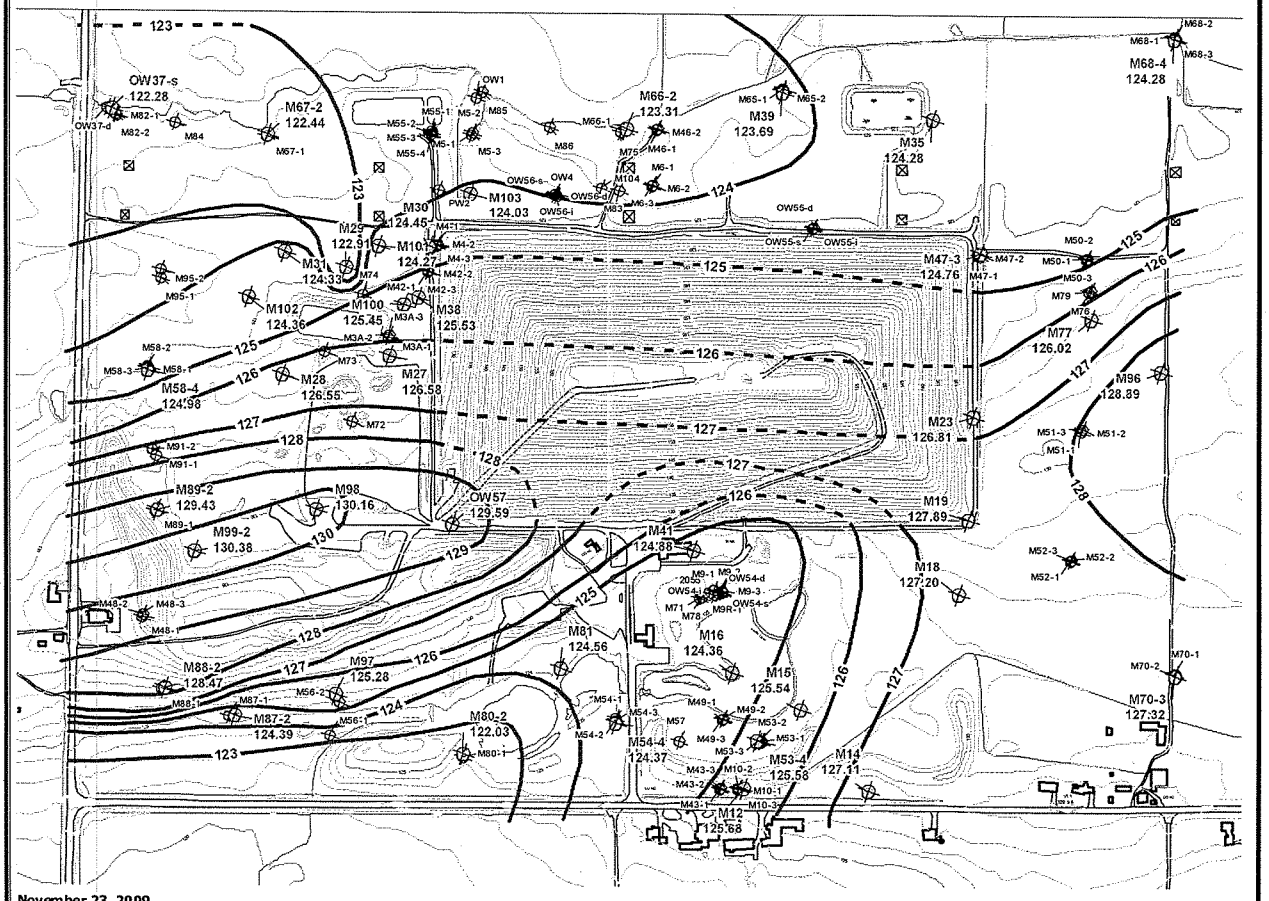
Units: Metres
UTM NAD 83 Zone 18
Scale: 1:2500



March 19, 2009



November 23, 2009

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Figure 4:
Shallow Bedrock Groundwater Flow Zone
Potentiometric Surface (2009)

M58-3 122.46 Monitoring Well with Water Level
M52-3 Other Monitor
Contour Lines
Potentiometric Surface (masl)

Project : K-B8579-00-02
Data Source: WM Canada, WESA, HPA Ltd. Base Mapping
Date: November 2010

50 25 0 50 100
Meters

Prepared by:
WESA Geomatics

Units:
UTM NAD 83 Zone 18

Scale: 1:5000

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A Golder Associates Company

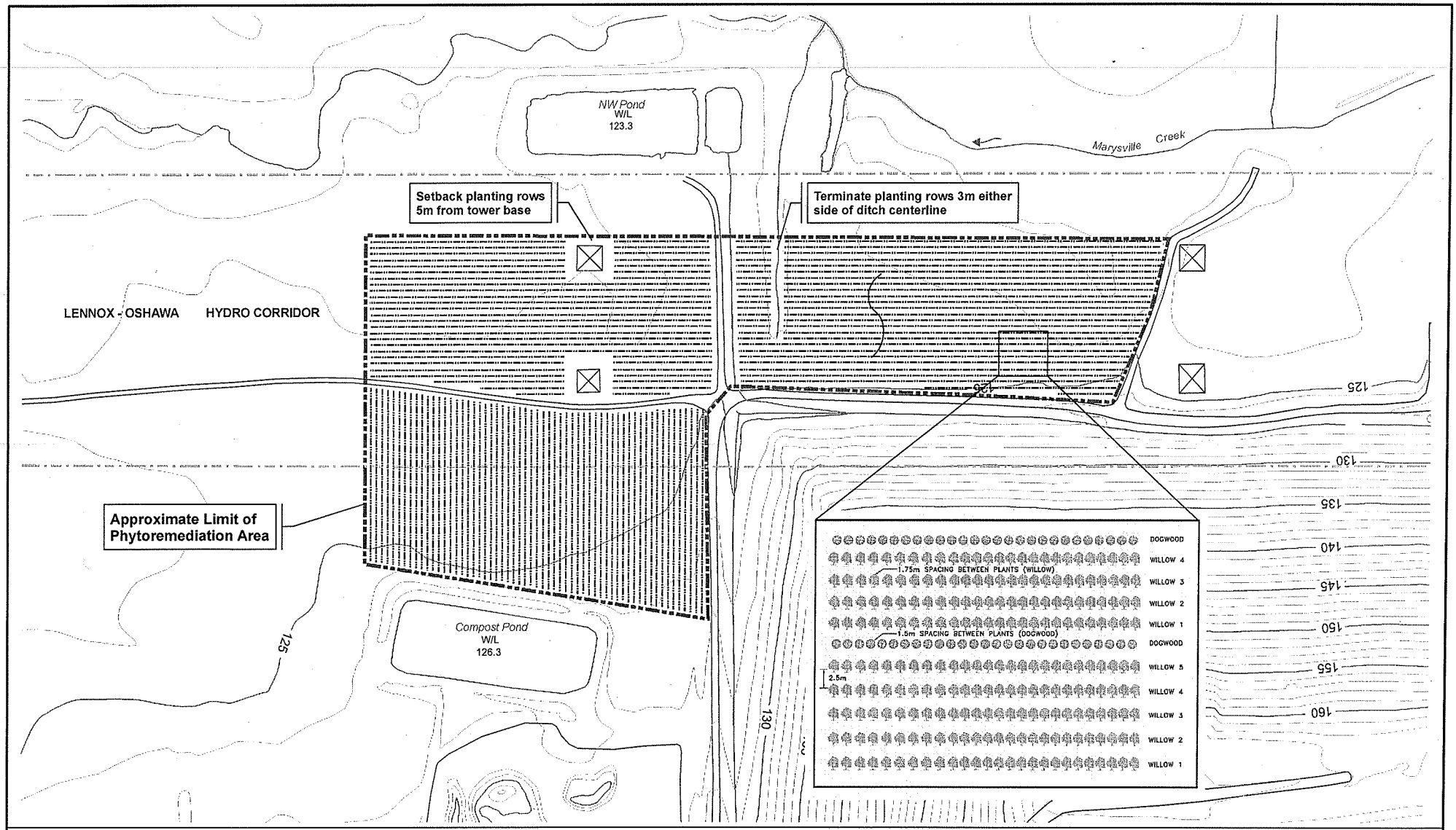

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Figure 5:
Phytoremediation Plantation Layout

Legend

Approximate Limit of Phytoremediation Area

Project: K-B8579-00-02
Data Source: WM Canada, WESA, HPA Ltd. Base Mapping(2009)
Date: November, 2010

Prepared by:
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Units: Metres
UTM NAD 83 Zone 18
Scale: 1:1500

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