Lynnwood Ravine LY12 & LY3 and LY4 Storm System Upgrading Projects and LY2A Sanitary System Project Environmental Screening Report

Final Report

Prepared for:

City of Edmonton, Asset Management and Public Works, Drainage Services, Design and Construction

Prepared by:

Spencer Environmental Management Services Ltd.
Edmonton, Alberta

Project Number (EP-347)

August 2007

Regulatory Comments Summary
Lynnwood Ravine LY12 & LY3 and LY4 Storm System Upgrading Projects and LY2A Sanitary System Project Environmental Screening Report

City of Edmonton Review

Review Comment	Response Approach	ESR Report Sections Reference
Edmonton Trasportation Department (Paul R. Lach)		
1. All excavation or regrading activities near the ravine slopes must be undertaken in a manner to minimize any potential adverse impacts on slope stability.	• ESR edited as requested	• Section 6.1.2.1
2. Every attempt should be made to preserve existing vegetation. Any significant vegetation clearing, excavation, and grading activities should be minimized at locations along the slopes or at the toe of the slopes.	• ESR edited as requested. • Number of trees to be removed in the Small ravine unknown until exact position of reception shaft for pipeline tunnel is determined	• Section 6.1.5.1 • Section 6.1.5.2
3. An Erosion and Sedimentation Control Plan must be prepared for the project and implemented prior to the work commencing.	• ESR edited as requested	• Section 6.1.2.1
4. Ensure that all erosion and sediment control systems are continually inspected and maintained during the construction process.	• Temporary erosion control measures will remain in place until vegetation becomes re-established in the disturbed areas and will be inspected regularly during the construction phase.	• Section 6.1.2.1
5. Suitable environmental protection practices must also be imposed to prevent and contain potential spills of fuels, oils, lubricants, and other hazardous materials arising from construction activities.	• ESR states that the contractor will follow standard operating procedures regarding hazardous materials spills.	• Section 6.1.2.5 • Section 6.1.5.5

Review Comment	Response Approach	ESR Report Sections Reference
Edmonton Trasportation Department (Brian Latte)		
No Comments		
Edmonton Engineering Services, Transportation Dept. (Dave Lapp)		
As long as the measures set out in the report to mitigate against releases of contaminants to the environment and the practices identified are followed to remediate unexpected releases, significant and long term impacts are not expected.	ESR states that the contractor will follow standard operating procedures regarding hazardous materials spills.	• Section 6.1.2.5 • Section 6.1.5.5
Edmonton Design and Construction, Drainage Services (Ellen Tian)		
No comments		
Edmonton Planner, South West (Tim Ford)		
No comments		
Parks Services, Asset Management & Public Works (Enrique Peris)		
Tree removal/relocation will require coordination with Forestry branch. An on-site meeting will be required in advance of construction to determine protection measures for trees located within laydown areas and adjacent to access points, to identify any sensitive areas which must be avoided by construction equipment, and to modify re-grading work adjacent to trees that have been identified for retention.	• As stated in this ESR, large trees in the construction area would be avoided or hoarded to protect them from damage and all removed trees would be replaced by the construction contractor pursuant to the City of Edmonton's Corporate Tree Management Policy.	• Section 6.1.5.2
Uncertainty regarding start dates and contractor availability is understandable under the current construction climate, but it is unclear why length of construction should remain unknown (as stipulated in section 2.3.8). An approximate estimate will be required for public	• The contractor will provide information concerning estimated duration of construction activities to Edmonton Drainage Services as soon as possible and include this information in their public mail-out (see	• Section 2.3.8

Review Comment	Response Approach	ESR Report Sections Reference
communication/inquiries. Please provide best estimate when available.	below)	
Laydown and access areas will be assessed both pre- and post-construction. Restoration will be the responsibility of the proponent and must be to the satisfaction of Parks branch. This includes all laydown and staging areas adjacent to ravine, and any ravine areas damaged by vehicle traffic.	• Reclamation plans will be included in the construction contractors' Landscape Maintenance Plan	• Section 6.1.2.2 • Section 6.1.5.1 • Section 6.1.5.3
Public communication is required for this project. Signage is recommended at ravine access points cited in section 5.2.5.2. A public mail-out to area residents should be performed in advance of construction. Notification should include information on nature of work to be performed, construction start date, approximate duration, and a contact number for inquiries.	• Contractor will undertake a mail-out of information notices to area residents. • Information signage (as specified in Section 6.2.3.1) will be installed at the locations specified in Section 5.2.5.2	• Section 6.2.3.2 • Section 6.2.3.1 • Section 5.2.5.2
We share the citizen concerns cited in Appendix D and want to protect the natural setting as much as possible. Please ensure that all landscape elements, including the Landscape Maintenance Plan be submitted for review/approval by Parks branch.	• The contractor will submit the Landscape Maintenance Plan to City of Edmonton Parks Branch for their review and approval	• Section 6.1.5.1 • Section 6.1.5.3

Executive Summary

Severe rain storms in 2004 resulted in approximately 6000 flooded basements in the City of Edmonton, with flooding in 237 (31%) of the 775 homes in the Lynnwood Community. Twelve thousand damage claims were made to insurance companies which resulted in payouts of about $160 million.

City of Edmonton Drainage Services undertook a rigorous review of how its infrastructure had performed during the storm event, a review which included preparation of the 2006 West Edmonton Flood Relief Conceptual Design Report. That report made important recommendations about how the drainage infrastructure performed within and around the Lynnwood Community which is the subject of this Environmental Screening Report.

The objectives of the proposed improvements are:

- For the sanitary sewer system improvement; to reduce the risk of basement flooding due to sanitary sewer backup.
- For the storm drainage system, to prevent or minimize to the extent practicable, the flooding of private property, especially houses, due to surface runoff from the street system, and to reduce the inflow/infiltration into the sanitary sewer system.

This can be achieved through improvements in the LY12 & LY3, and LY4 projects for the storm drainage system and the LY2A & LY5B projects for the sanitary system, as follows:

- Reducing the backup of sanitary sewers into house basements by increasing the capacity of the system and by diverting flows to a new trunk system (LY2A & LY5B). Upgrading the existing storm sewers to increase the storm system pipe capacity and conveying flows into the Lynnwood Ravine to reduce flooding from surface runoff.
- Limiting the amount of surface flow and reducing ponding times on streets and sags, and minimizing inflow into the sanitary sewer system from surface waters through the installation of additional catch basins which contribute to the upgraded 1800mm pipe in the Main ravine.
- Installing an inlet/overflow structure to allow excess water from the 1800mm pipe under the main ravine to flow onto the ravine surface during major storm events.
- Using the storage capacity of the Lynnwood Ravine to temporarily capture excess flows for short periods of time during major storm events.
- Adding another outlet pipe opening on the ravine floor to limit the ponding time and water levels in the ravine.

The LY12 & LY3 Storm System Improvement Project consists of two parts. The LY12 Project consists of :

- Allowing surface flows from 156 Street to be drained overland into the Lynnwood Ravine, which will require curb cutting and regrading of the the ravine to provide positive flow to the inlet/overflow structure constructed in LY3.

The LY3 Project consists of:

- Replacement of 40m of storm pipe from 1200mm to 1800mm Ø.
- Ravine bottom re-grading and reshaping to provide positive grades with side slopes at a maximum 3:1 ratio to match existing grades. This will include landscape restoration using sod, relocation of trees displaced by construction and planting of new shrubs.
- Installation of a Ravine Inlet/Overflow structure.
- Upgrading of the existing ravine outlet pipe capacity by adding a 1200 mm outlet structure to the existing 200 mm opening.
- Addition of catch basins upstream of the 1800mm storm pipe.

The LY4 Storm System Improvement Project consists of :

- Upgrading the conveyance capacity of the existing storm trunk along 152nd Street, which connects to the pipe system under the Lynnwood Ravine.
- Twinning the existing trunk along 152nd Street by tunneling at the same alignment of the new sanitary trunk alignment, the LY2A (which will connect to the LY5B project).

The LY2A & LY5B Sanitary System Improvement Project consists of :

- Upgrading the conveyance capacity of the existing sanitary system by intercepting flows and connecting at the 87th Avenue trunk system.
- Using the same alignment as the LY4 pipe twinning improvement for the new sanitary trunk sewer as well as using the one location for both storm & sanitary structures located within the Main ravine to connect the LY2A to the LY5B sanitary trunk

Addressing one report for all of the above-named projects will provide project synergies and provide an integrated report to Planning and Development for approval as required by Bylaw 7188.

There are two potentially positive impacts resulting from the Lynnwod Ravine projects:

- decreasing the possibility of residence flooding due to storm water ponding. This has the added benefit of reducing the risk of basement flooding from sanitary sewer backup; and
- decreasing the negative effects of stormwater ponding on slope stability.

There are eight potential adverse impacts which include:

- Reduced ravine access and use during construction.
- Traffic and parking disruptions due to construction activities.
- Noise from construction activities.
- Some loss of natural vegetation and relocation of ornamental trees.
- Some loss of wildlife habitat.
- Possible loss of native trees.
- Altered views within the ravine.
- Potential damage to local roadways.

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1.0 INTRODUCTION

1.1 Background

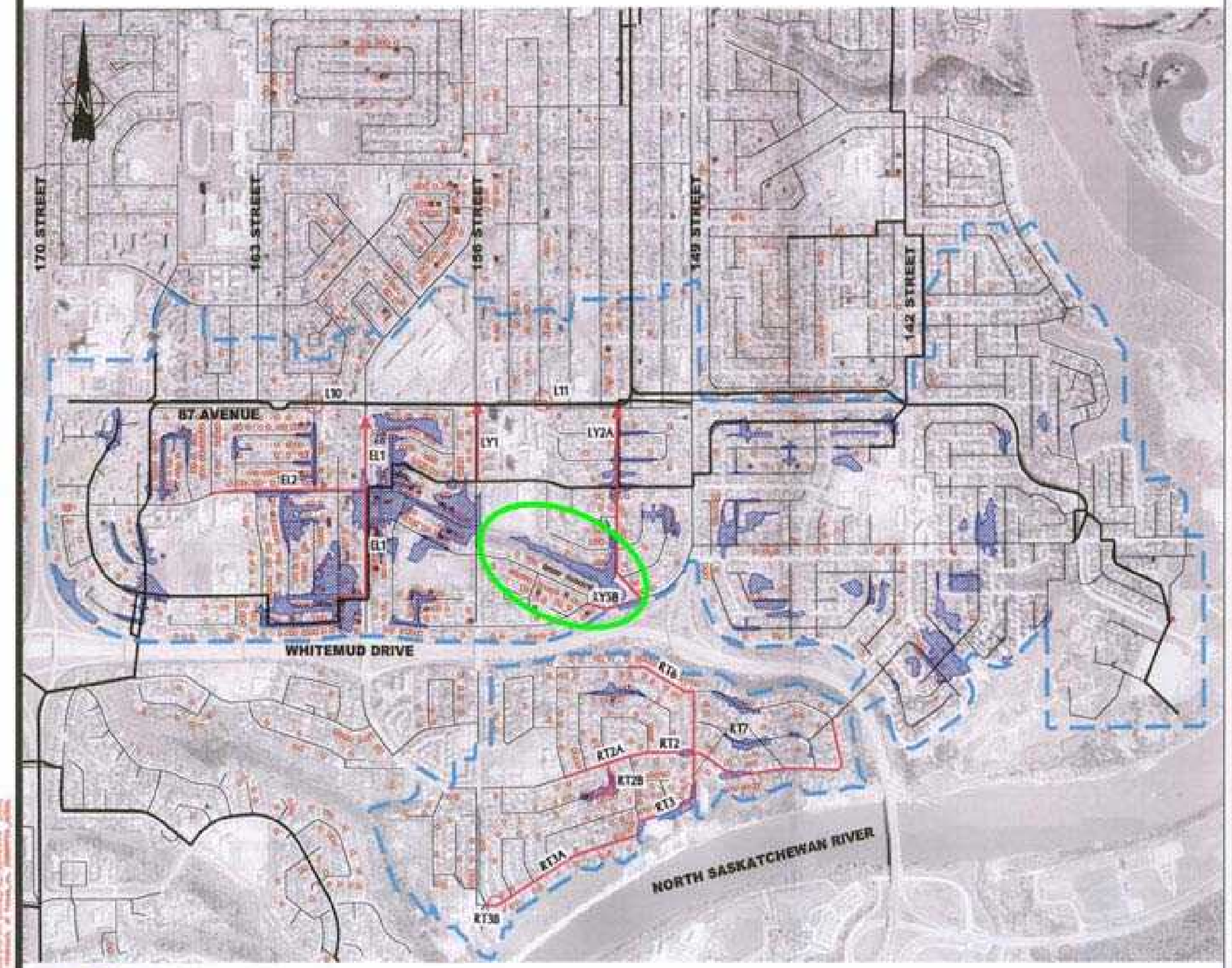
The Lynnwood Ravine is a tributary ravine to the Quesnell Ravine that ultimately joins the North Saskatchewan River in southwest Edmonton on the north side of the North Saskatchewan River Valley (Figure 1.1). The Lynnwood Ravine commences on 156th Street at about 82nd Avenue. It was formerly occupied by a small stream but to facilitate development in west Edmonton, the ravine bottom was filled and a stormwater pipe installed beneath the fill in 1967.

On 11 July 2004, an intense convective storm system moved over the southwestern part of Edmonton and dumped approximately 150 mm of rain in less than one hour. That amount of rain, combined with large hail, clogged the city's storm drainage system and created a 1-in-200 year flash flood event (Phillips 2004), centered around the Lynnwood Community. The flood resulted in approximately 6000 flooded basements in the city, with flooding in 237 of the 775 homes (31%) in the Lynnwood area (Earth Tech 2006). The ponding and subsequent movement of storm water within the Lynnwood and adjacent communities resulting from intense rainfall is illustrated in Figure 1.2. Twelve thousand damage claims were made to insurance companies which resulted in payouts of about $160 million (Phillips 2004).

City of Edmonton Drainage Services undertook a rigorous review of how its infrastructure had performed during the storm event. That review included preparation of the West Edmonton Flood Relief Conceptual Design Report (Associated Engineering 2006). That report established a regional framework for the infrastructure improvements necessary to avoid the types of property damage that had resulted from the 2004 storm event. It also addressed the situation in the Lynnwood Community and made specific recommendations about how drainage infrastructure in the community and within the Lynnwood Ravine should be adjusted. An important component of developing the conceptual plan was a continuing program of community consultation represented by public meetings with Lynnwood Community residents (see Section 3.3).

The Lynnwood Ravine complex is composed of two sections (Figure 1.3):

- Main Ravine - a short (605 m) and narrow (35 m to 42 m), shallow ravine which runs southeast from the junction of 82nd Avenue and 156th Street until it reaches the north side of the Whitemud Freeway, from which it is separated by an embankment.
- Small Ravine – a very short (213 m) and narrow (20 m to 25 m), shallow ravine which begins at 83rd Avenue and Lynnwood Way and runs directly south until it merges with the Main Ravine. It is bisected by 82nd Avenue.



Associated Engineering

Edmonton

WEST EDMONTON FLOOD RELIEF CONCEPTUAL DESIGN

PROPOSED SANITARY SEWER SYSTEM UPGRADES

LEGEND:

- BASIN BOUNDARY
- EXISTING TRUNKS
- FLOODED HOUSES
- SEWER UPGRADING
- INTERCEPT EXISTING TRUNK
- SEAL MANHOLE VENTS IN LOW AREAS
- LYNNWOOD RAVINE

Figure 1-1.
Location of Lynnwood Ravine in West Edmonton

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

SCALE: 1 : 15000

DECEMBER, 2005

Legend

- Stormwater Drainage Path
- Low Areas Subject to Stormwater Ponding
- Main Ravine
- Small Ravine
- NSRV Area Redevelopment Plan Boundary
- Direction of Stormwater Drainage Flow

N

1:10,000

0 50 100 200 Meters

Figure 1-2. Lynnwood Ravine Regional Location

SPENCER ENVIRONMENTAL
MANAGEMENT SERVICES LTD.

Legend

Lynnwood Ravine

- Main Ravine
- Small Ravine
- Borehole

Boreholes:

1- TH0601	5- 7100467-02
2- TH0602	6- 7100467-03
3- TH0603	7- 7100467-04
4- 7100467-01	8- 7100467-05

N

1:3,500

0 25 50 100 Meters

Figure 1-3. Lynnwood Ravine Study Area

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MANAGEMENT SERVICES LTD.

In analyzing the 2004 storm, engineers identified several problems with the existing drainage infrastructure in the Lynnwood Ravine area that resulted in the ravine being flooded and as a result, the basements of some nearby homes also being flooded. Those problems included the following:

- The bottleneck where the 1800 mm pipe changes to 1200 mm Ø pipe within the ravine backs up in the system for some distance upstream (west) of 159th Street.

- The existing stormwater piping within the Lynnwood Ravine had insufficient capacity to handle the volume of stormwater that entered it.

- The outlet structure at the low end of the Lynnwood Ravine was too small to efficiently drain the surface water (once the peak of the storm had passed) which ponded behind the berm which separates the southeast terminus of the Main ravine from the Whitemud Freeway.

Using the Conceptual Design Report (Associated Engineering 2006) as a guide, City of Edmonton Drainage Services identified several separate component projects to be undertaken to implement recommendations in the Conceptual Design Report.

The LY3 project is an overflow pipe from the Lynnwood Trunk to the Lynnwood (Main) Ravine, where the trunk size reduces from 1800 mm to 1200 mm diameter.

- Excess runoff would spill into the ravine where it would be temporarily stored. The overflow would reduce surcharging in the area west of 156th Street where several deep trapped sags are flooded in a major storm event.
- Surcharging to be limited just below ground surface where possible.
- Three hours retention time within the ravine for the 1:100 year event

The LY4 project involves improving the in-ground and surface stormwater drainage infrastructure in the Small ravine.

The proposed storm system improvements within the Lynnwood Ravine are located within the Bylaw 7188 area requiring this Environmental Screening Report. It is also subject to the City of Edmonton Corporate Tree Policy. One report is being submitted for all the projects involving work within the ravine.

Future projects that would involve working in the Lynnwood Ravine will be implemented at the same time to achieve synergies and provide less disturbance to the Ravine. These projects included:

- LY2A - Sanitary System improvement calling for a new pipe to be installed at the same alignment as the LY4 storm system improvement.

- LY5B - The current alignment of this sanitary system improvement connects to the LY2A improvement which will cut across the bottom of the Main ravine.

In order to achieve synergies with the proposed LY3 and LY4 storm system upgrades located within the Lynnwood Ravine, it was determined that it would prove more cost effective and less disruptive to the ravine if all proposed improvements are coordinated. On this basis, LY3 and LY12, has been scheduled for 2007 Fall construction, followed by LY4 and LY2A & LY5B for 2008 construction. This ESR covers the LY3, LY12, LY4 and LY2A projects. The LY5B project impacts the ravine if the constructed method chosen will require open trench cut within the ravine. This item is not covered in this ESR except for the working shaft located in the Lynnwood Ravine which will tie both the LY5B and LY2A sanitary sewer lines to the existing sanitary sewer trunk. There will be one disturbance in the ravine to expose the infrastructure which connects both LY2A and LY5B and LY4.

While preliminary engineering information is available for the environmental assessment of the LY3, LY12 and LY4 components, only conceptual design information is available at this time for the sanitary sewer line components (LY2A & LY5B).

The objectives of the LY12 & LY3 Project are:

- to reduce water surcharge levels in the piped system and reduce flooding of the streets along 83rd Avenue between 156th and 159th Streets;
- to reduce basement flooding which occurs during excessive sanitary sewer inflows, from surface water ponding;
- to use Lynnwood Ravine for the purpose of stormwater management with a lowered residence time for flood water retention in the ravine; and
- to reduce ponding levels on the street sags due to inadequate catchbasin capacities.

Those LY12 & LY3 objectives are to be accomplished by:

- Increasing the pipe capacity by replacing 40m of 1200 mm pipe with 1800 mm pipe, and by installing an inlet/overflow structure into the existing storm drainage system within the main ravine.
- Limiting the surface ponding on street sags by adding new catchbasins, cutting curbs along 156th Street and regrading the surface of the Main Ravine. This will allow positive overland drainage into the ravine during major storm events, thereby reducing inflow into sanitary manholes and avoiding sanitary backups caused by added inflows from surface ponding.
- Installing an inlet/overflow structure to allow pipe surcharge to drain via surface flow, utilizing the ravine as a stormwater management structure during major storm events. This will providing a means for stormwater surcharge in the existing pipe to be diverted onto the ravine surface for short-term water storage. Enlarging the outlet pipe from a 200 mm to a 1200 mm opening will reduce the residence time for flood waters which are stored in the ravine.
- Installing additional catchbasins to convey flows into the 1800 mm pipe and reduce stormwater ponding time and levels.

The objectives of the LY4 Project are:

- to increase the conveyance of the stormwater pipe and reduce surface ponding;
- to lower the surcharge levels in the stormwater piped system;
- to reduce the surface flooding on the streets; and
- to reduce inflows into the sanitary sewer system, thus lowering the associated risk of basement flooding in nearby residential homes

Those LY4 objectives are to be accomplished by:

- modifying the existing 1200 mm stormwater pipe system located at 152nd Street, and
- increasing the hydraulic gradient (0.35% versus the existing 0.2%) to increase water conveyance out of the Lynnwood community.

The objectives of the LY2A and LY5B Project are to install a sanitary sewer relief line to reduce the risk of basement flooding from sanitary sewer backup, as per the recommendations of the West Edmonton Flood Relief Conceptual Design (associated Engineering 2006). This LY2A & LY5B objective will be accomplished by:

- installing a new sanitary trunk, LY2A & LY5B, to divert sanitary flows to a larger downstream system using the same alignment as the LY4 twinning option and using trenchless construction methods. The sewer lines will be constructed at the same time as the LY4 storm water line and placing both the LY4 and LY2A lines within the same tunnel.
- route the LY4, LY2A and LY5B lines to a common working shaft located within the Main ravine so that they can all be connected to the existing underground infrastructure at the same time.

1.2 Environmental Screening Objectives

The project area lies within the boundaries of the North Saskatchewan River Valley (NSRV) Area Redevelopment Plan (Bylaw 7188), which requires an environmental review of all projects situated on City-owned lands within the Area Redevelopment Plan (ARP). Consultation with the Bylaw administrators (Edmonton Planning and Development) indicated that an Environmental Screening would be the appropriate level of environmental review for this project.

The objectives of this Environmental Screening exercise were to:

- obtain sufficient information about key Valued Environmental Components (VECs) that could be potentially impacted by the proposed project,
- describe the potential impacts of the stormwater drainage upgrades and provide that information to project engineers and planners for consideration in the construction of the upgrade,
- identify mitigation measures for any potential impacts identified in the ESR that cannot be eliminated through design,

- identify applicable environmental permitting pathways,
- prepare an environmental assessment document that will meet the requirements and informational needs of the City of Edmonton, and
- obtain approval-in-principle for the project from Edmonton Planning and Development pursuant to Bylaw 7188.

1.3 Study Area

The local study area includes the bottom and sides of the Lynnwood Ravine (referred to hereafter as the Main ravine) and the bottom and sides of an adjacent subsidiary ravine (referred to hereafter as the Small ravine) and the open grassy area at the southeast end of the Main ravine. Study area boundaries were selected based on consideration of the following:

- Ecologically relevant boundaries.
- Potential recreational impacts.
- Potential for surface erosion during the project construction phase.
- Potential for surface erosion of the ravine sides during any future severe storm events.

Based on those criteria, the study area was bounded on the north and south sides by the presence of private residences and the Lynnwood School grounds, at the western end by 156th Street and on the eastern end by Lynnwood Way.

1.4 Bylaw 7188 Environmental Review Process

Environmental assessments prepared for City of Edmonton Asset Management & Public Works Dept (AMPW) pursuant to Bylaw 7188 are routinely circulated by that City department to appropriate federal and provincial government departments for review. There is also potential for this project to trigger permits and approvals from other levels of government.

1.5 Report Organization

This report comprises 8 chapters. Chapter 1 provides background information related to the project, the location of the study area and describes the report structure. Chapter 2 is the detailed project description, including project rationale, scope of the work, alternatives considered, construction scheduling and the environmental permitting process. Chapter 3 outlines the environmental screening methodology and the public consultation process. Chapter 4 summarizes the key environmental and socio-environmental issues associated with the project, incorporating professional and regulatory concerns.
Chapters 5 and 6 are organized to describe each potentially affected resource in terms of Valued Environmental Components (VECs). The existing conditions for all VECs are described in Chapter 5. Impacts related to project implementation, any recommended mitigation measures and the residual impacts after mitigation are described in Chapter 6. Chapter 7 summarizes findings of the ESR assessment and review steps taken to resolve issues of concern identified during the assessment.

Chapter 8 provides all references and personal communications cited in the report.

Appendices to this ESR include:

- Appendix A. Rainfall Data for the Edmonton Region
- Appendix B. Constructability and Risk Assessment Workshop for the LY3 Project
- Appendix C. Constructability and Risk Assessment Workshop for the LY4 Project
- Appendix D. Open House Summary
- Appendix E. Geotechnical Boreholes Logs for the LY3 Project (Main Ravine)
- Appendix F. Geotechnical Boreholes Logs for LY4 Project (Small Ravine)
- Appendix G. Vegetation of the Lynnwood Ravine
- Appendix H. Plant Species within each Plant Community
- Appendix I. Birds of the Lynnwood Ravine and Surrounding Region
- Appendix J. Mammals of the Lynnwood Ravine and Surrounding Region
- Appendix K. Lepidoptera of the Lynnwood Ravine and Surrounding Region

2.0 PROJECT DESCRIPTION

2.1 Declaration

The proponent for the project components of the overall project is the City of Edmonton Asset Mangement and Public Works Department, Drainage Services Branch, Design and Construction.

Spencer Environmental is the environmental consultant responsible for preparation of this ESR.

This report represents the findings and conclusions of the environmental consultants, but it also incorporates the suggestions and comments from the proponents and interested City of Edmonton departments. The specific mitigation measures outlined in this document will be followed by the City of Edmonton as part of their commitment to environmental best management practices and technologies.

2.2 Project Rationale

The proposed storm system improvement projects (LY3 and LY4) are being done in order to increase the capability of the storm water drainage system to handle high water flow loads during severe storm events in the Lynnwood Community. These projects are using the combined capacities of the existing storm water drainage infrastructure and the topography of the Lynnwood Ravine to drain and store storm water from the surrounding residential communities, thereby decreasing the possibility of flooding along the streets and sewer inflows to residential basements.

There are several benefits accruing from the Lynnwood Ravine projects:

- The proposed upgrades will reduce the amount of surcharging of the storm sewers below the road surface.
- Storm water drainage will be improved by reducing the volume of water ponding on the streets which would otherwise contribute to inflow into the sanitary system.
- Flooding of private property due to sanitary sewer backups will be reduced.
- They will lower the surcharge levels and street flooding in major storm events such as 1:100 year storms or the 1:200 year 11 July 2004 storm.

The greatest benefits will occur in the Lynnwood and Elmwood neighbourhoods (from 156th Street to 163rd Street), where there are several deep trapped sags.

Increasing the drainage capacity of the Lynnwood Ravine as part of a regional upgrading to the storm water drainage system was identified in the West Edmonton Flood Relief Conceptual Design Report (Associated Engineering 2006).

The sanitary sewer line components (LY2A and LY5B) of the project were included in the overall project as a result of detailed engineering for the storm system improvements .

When considering construction alternatives for the LY4 project, it became apparent that there were near-future plans to replace the existing sanitary sewer line below 153rd Street. That project

was originally scheduled for 2008. The LY4 project is scheduled for 2007 but that would have meant disturbing the same area twice in short duration. City of Edmonton Drainage Services determined that it was preferable to advance the schedule of the sanitary sewer line project and take advantage of the synergies of simultaneously installing both projects.

2.3 Detailed Project Description

2.3.1 Project Setting

The Lynnwood Ravine is a shallow ravine with an open, turf bottom and narrow, densely treed sides. It is located within the heavily urbanized community of Lynnwood, with residential housing surrounding it on all sides, a school yard adjacent to the northwest corner and the Whitemud Freeway along the southeast end. The back yards of houses line the border of the Main ravine and the border of the Small ravine is comprised of private yards and residential streets.

2.3.2 Project Limits

This ESR covers those lands within the Main and Small ravines that are included within the Bylaw 7188 boundaries. This includes the natural vegetation of the side slopes, the manicured grasslands of the ravine bottoms and the manicured boulevards up to both the nearby roads and the tall berm which forms the border between the southeast end of the Main ravine and the north side of the Whitemud Freeway.

2.3.3 Scope of Work

The following key components comprise the LY3, LY12, LY4, and LY2A projects:

- Increase the size of the stormwater pipe in the upper part of the Main ravine.
- Install an inlet/overflow structure on the surface of the Main ravine.
- Install an additional stormwater pipe in the Small ravine.
- Install a larger outlet pipe opening near the existing manhole cover located at the southeast end of the Main ravine..
- Coordinate the installation of the LY2A & LY5B sanitary sewer lines with the LY4 project, including using one location in the ravine to connect LY5B & LY2A and LY4.

The project requirements for each of these five components are listed below. Information for each of these components was obtained from three sources: the Lynnwood LY3/L13 Ravine Inlet/Outlet Controls Project Preliminary Design Report (Earth Tech 2006), the Lynnwood LY4 Storm Trunk Upgrading Draft Preliminary Design Report (Sameng 2006) and revisions made to both of these projects made by City of Edmonton Drainage Services engineers (Leonora Lumabi, *pers. comm.).*

2.3.3.1 LY3 Storm Water Pipe and LY12 Curb Cutting

A Structured Risk Analysis Process was used at a Constructability Workshop held on 11 October, 2006. That workshop included participants from the City of Edmonton, Earth Tech, Sameng and Spencer Environmental. The findings of the workshop indicated that the following was the best option for the LY3 project, given the risk analysis, environmental impact and cost estimate.

The curb along 156th Steet will be cut down to street level to allow flood waters to enter the Main ravine via surface flow. The existing 1200 mm storm sewer pipe at the western end of Main ravine will be replaced with a 40 m section of 1800 mm pipe. This new pipe will begin at a point 30 m west of 156th Street and will be joined to the existing 1200 mm pipe and also to an overflow structure (see Figure 2.1).

2.3.3.2 LY3 Inlet/Overflow Structure

The inlet/overflow structure will allow any water surcharge in the 1800 mm pipe to flow onto the ground surface of the ravine. To maintain the hydraulic performance of this overflow so it will flow down the ravine, the ground surface will be shaped. This selective re-shaping of the ravine ground surface will be limited so as to preserve existing large trees. To guarantee that the water flowing onto the surface does not pool around the overflow structure once severe storm events are over, reverse grading at the overflow structure will drain directly into the 1800mm pipe when capacity is available (i.e. as the water volume in the pipe lessens).

This surface grading will involve removal of soil up to an average depth 1.5 m, and a re-shaping the ravine bottom with maximum 3:1 side slopes where the grounds are to be mowed (see Figure 2.2). The sides of this newly shaped ground surface will have 3:1 side slopes to the existing ravine slopes and a 15:1, 5:1 and 7:1 longitudinal slopes above and beyond the structure.

Surface regrading in the Main ravine will extend 72 m eastward into the ravine from the curb at 156th Street. The area affected by regrading will be along the open cut trench and will be, on average, 2.5 m wide, except at the placement site for the overflow structure. At that site, disturbance around the structure resulting from its installation will impact an area approximately 16 m wide.

The inlet overflow structure will not exceed the 1.0 m^3/s flow velocity recommended by the City of Edmonton. The size of the overflow structure on the ravine ground surface will be a 3000 mm x 1500 mm box structure covered with steel grating and will be flush to the ground, or very close to the ground surface, such that it is neither a safety issue for the public or an unaesthetic feature.

2.3.3.3 LY4 Storm Water Pipe

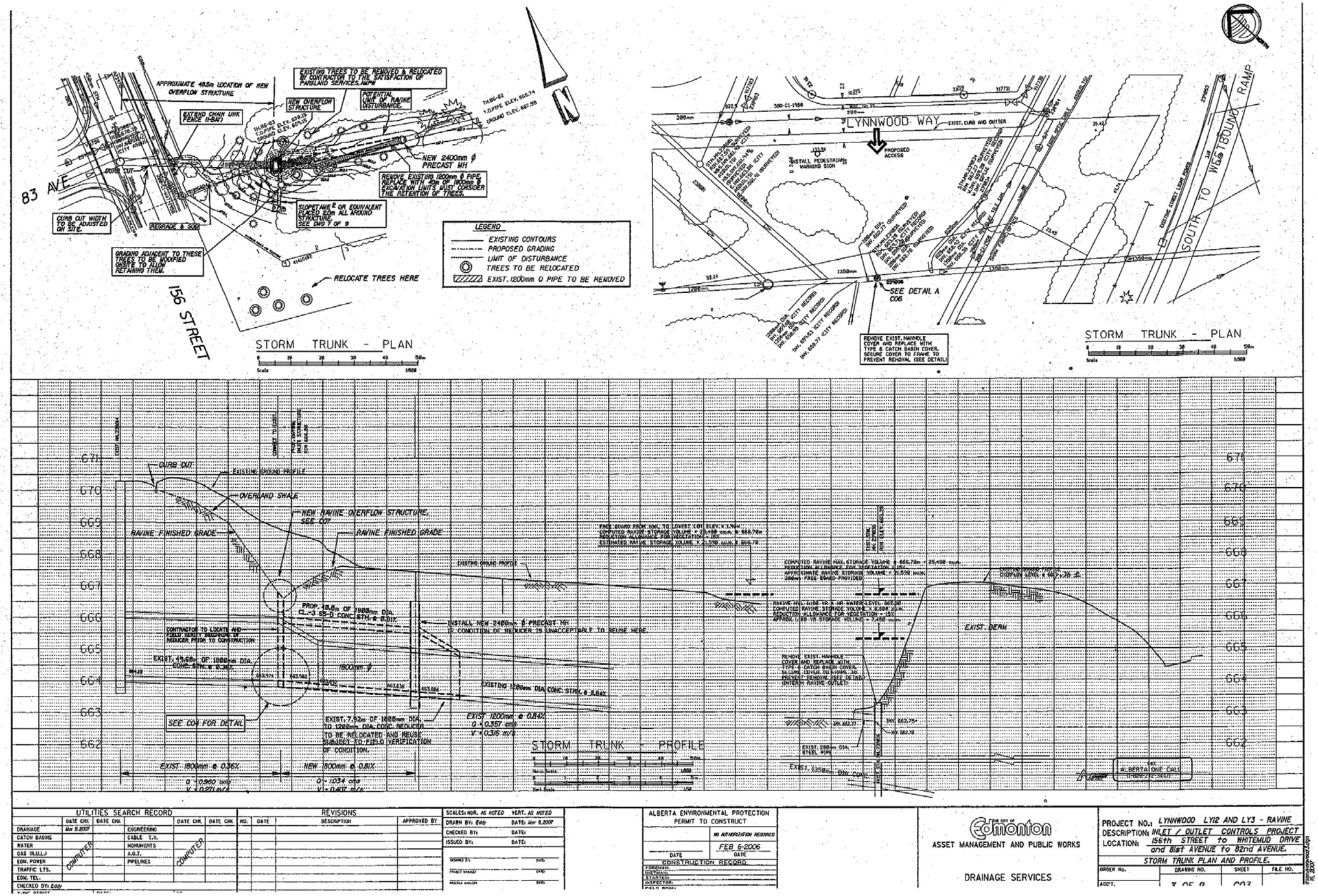
The conveyance capacity of the existing 1200 mm trunk sewer will be augmented by the installation of a 1050 mm storm trunk which runs almost parallel to the existing trunk. That new pipe would branch off the existing line at 152nd Street and 83rd Avenue and travel under the Small ravine to join with the existing 1200 mm pipe at the end of the Main ravine (see Figure 2.3).

There are two possible construction methods, both of them trenchless, below-ground installation methods. The first possibility is microtuneling which would require a large (7 m) vertical working shaft on 83rd Avenue and a smaller reception shaft within the Main ravine near its southeast end. A cutting head would produce the tunnel, removing soil and transporting it back to the working shaft. Once the tunnel is dug, a jacking frame will be used to push the new 1050 mm pipe into place.

The second possibility is hand-tunneling. This method would require a 3 m pit along the south side of 82nd Avenue, from which two teams of workers would simultaneously tunnel north and south, towards reception pits on 83rd Avenue and in the Main ravine. This process would produce a larger tunnel than with microtunneling, through which the 1050 mm pipe could be jacked.

The advantages to the underground construction methods are as follows:

- There will be minimal disturbance to the existing 1200 mm trunk, and it would remain in service during and after construction of the new storm sewer.
- Transportation in the immediate neighbourhood will be less disrupted.
- Sanitary and water connections will not need to be disturbed during the construction phase.
- Maintaining surface water drainage during the construction phase will be simplified.



UTILITIES SEARCH RECORD						
	DATE CHK	DATE CHK		DATE CHK	DATE CHK
DRAINAGE	Mar 9.2007		ENGINEERING		
CATCH BASINS			CABLE T.V.		
WATER	COMPUTER		MONUMENTS	COMPUTER	
GAS (N.U.L.)			A.G.T.		
EDM. POWER			PIPELINES		
TRAFFIC LTS.					
EDM. TEL.					
CHECKED BY: Eddy					

REVISIONS			
NO.	DATE	DESCRIPTION	APPROVED BY

SCALES: HOR. AS NOTED VERT. AS NOTED
DRAWN BY: Eddy DATE: Mar 9.2007
CHECKED BY: DATE:
ISSUED BY: DATE:
DESIGNED BY: DATE:
PROJECT MANAGER: DATE:
PROGRAM MANAGER: DATE:

ALBERTA ENVIRONMENTAL PROTECTION
PERMIT TO CONSTRUCT
NO AUTHORIZATION REQUIRED
DATE FEB 6-2006 DATE
CONSTRUCTION RECORD
FOREMAN:
SUBMAN:
STARTED:
INSPECTOR:
FIELD BOOK:

The City of Edmonton
ASSET MANAGEMENT AND PUBLIC WORKS
DRAINAGE SERVICES

PROJECT NO.: LYNNWOOD LY12 AND LY3 - RAVINE
DESCRIPTION: INLET / OUTLET CONTROLS PROJECT
LOCATION: 156th STREET to WHITEMUD DRIVE and 81st AVENUE to 82nd AVENUE.
STORM TRUNK PLAN AND PROFILE.

ORDER NO.	DRAWING NO.	SHEET	FILE NO.
ACCT.	3-05-8	003	

Figure 2.1 LY3 Storm Trunk Extension

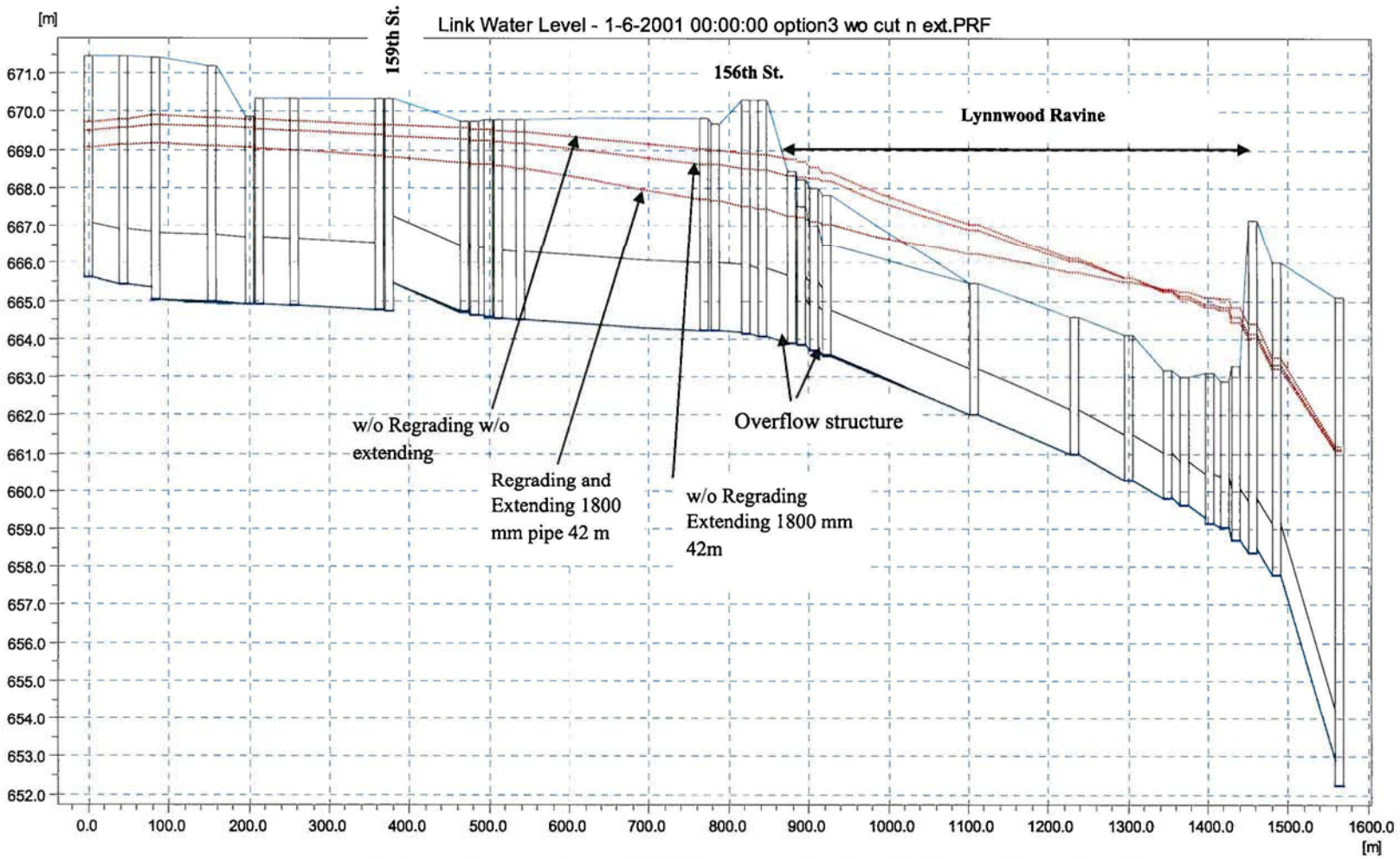


Figure 2-2: Regrading Ravine vs. W/O Regrading Ravine (1:100 year 4 hour Event)

LY3- Outlet Pipe Opening
The outlet structure to remove stored flood waters in the ravine from the southeast end of the Main ravine will be incorporated in the LY4 manhole connection to the existing 1350 mm pipe. This will include replacing the manhole cover with a grated cover as well as maintaining the existing 200 mm opening to drain the deepest portion of the ravine. A computer model simulation indicated that the current outlet structure would require 20 hours to empty the ravine after a 1:100 year 4 hour storm event. This new, larger outlet structure would reduce this water ponding time to just under 3 hours (see Figure 2.4). The exact location of the LY4 chamber will be finalized in the LY4 design component.

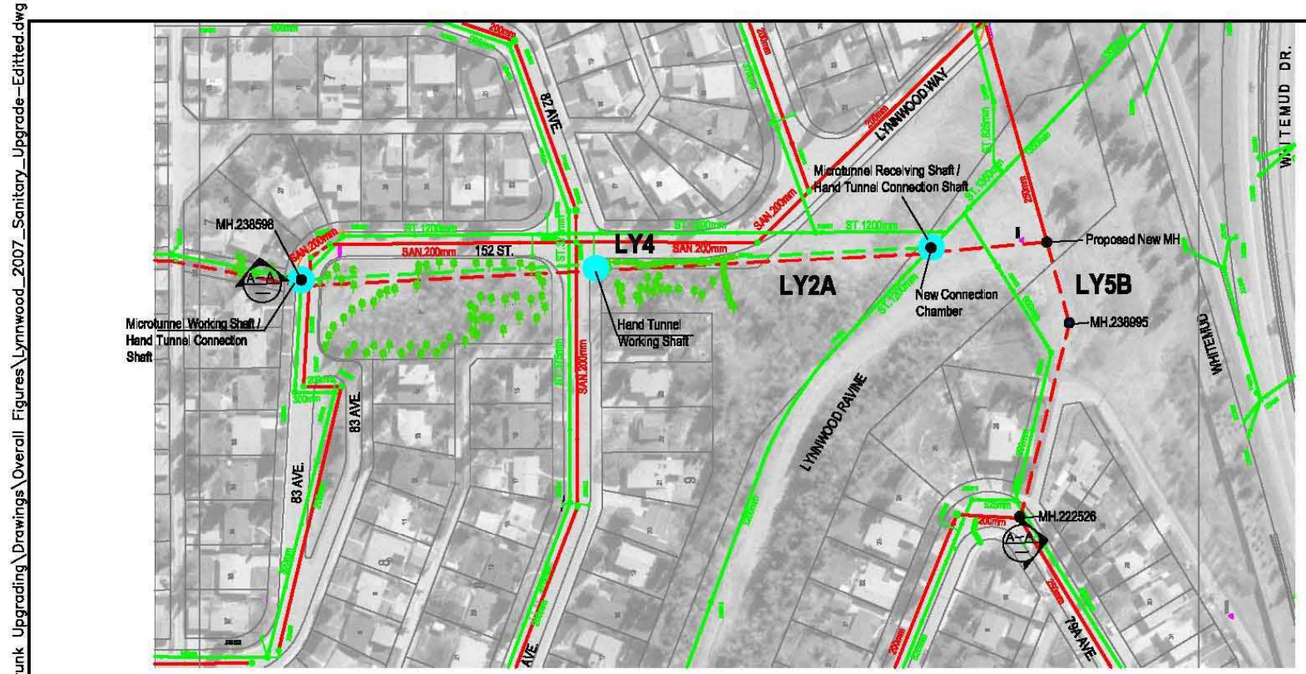
2.3.3.4 LY2A & LY5B Sanitary Sewer Line.

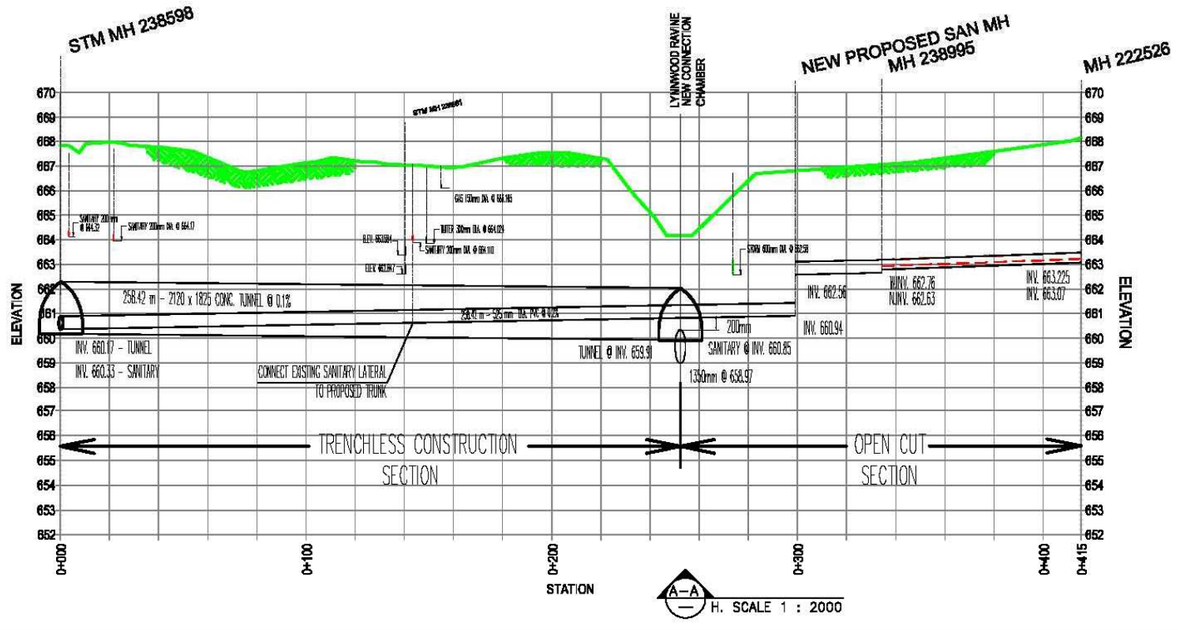
The 525 mm LY2A sewer line will extend south from the junction of 152nd Street and 83rd Avenue to the south end of the Main ravine, where it will be joined to the proposed LY5B sanitary sewer line which will run east-west cross the south end of the Main ravine (see Figure 2.3). The LY2A sewer line will be installed in the same alignment as the LY4 stormwater line, so the construction installation methods will be identical to the LY4 project.

The LY5B is a proposed project and is not covered by this ESR but is mentioned because of the necessity for the LY2A and LY5B sanitary sewer lines to be connected in order for the LY5B line to relieve the sanitary sewer system pressure in the residential area south of the Lynnwood Ravine.

2.3.4 Construction Protection Measures

Responsibility for construction protection measures will lie with the construction contractor and, therefore, cannot be fully specified at this time. It is expected that appropriate fuel handling procedures, construction materials handling protocols and occupational health and safety requirements will be followed. In addition, those construction protection measures with environmental implications covered in this ESR will be implemented according to measures specified in this ESR. This project description assumes that all best management practices relating to erosion control, fuel storage and handling and reclamation will be employed.





LEGEND

- EXISTING GROUND
- EXISTING STORM PIPE
- EXISTING SANITARY PIPE
- PROPOSED STORM TUNNEL
- PROPOSED SANITARY PIPE
- POTENTIAL SHAFT LOCATION

Prepared By

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better water | better world

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THE CITY OF Edmonton

LYNNWOOD LY4 / LY2A / LY5B STORM AND SANITARY UPGRADING

LY4 / LY2A TUNNEL PROFILE. INSTALLATION OF SANITARY TRUNK 525 MM and STORM TUNNEL

JOB#: 817 AUTOCAD FILE: Z:\City of Edmonton\Lynnwood LY4 Storm Trunk Upgrading\Drawings\Overall Figures\Lynnwood_2007_Sanitary_Upgrade-Editted.dwg

Figure 2.3 Lynnwood LY4 Storm Trunk and LY2A & LY5B Sanitary Sewer Upgrading

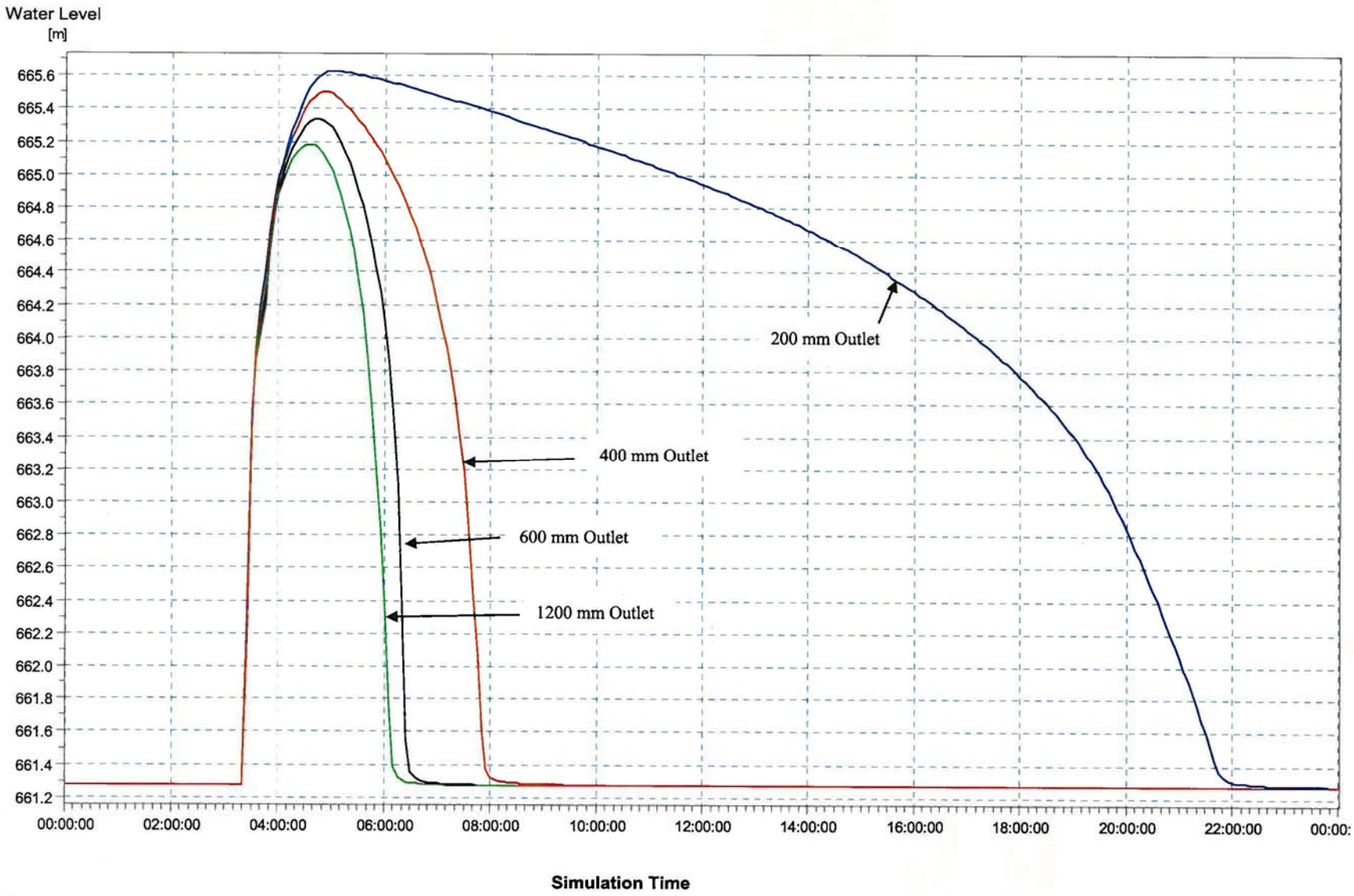
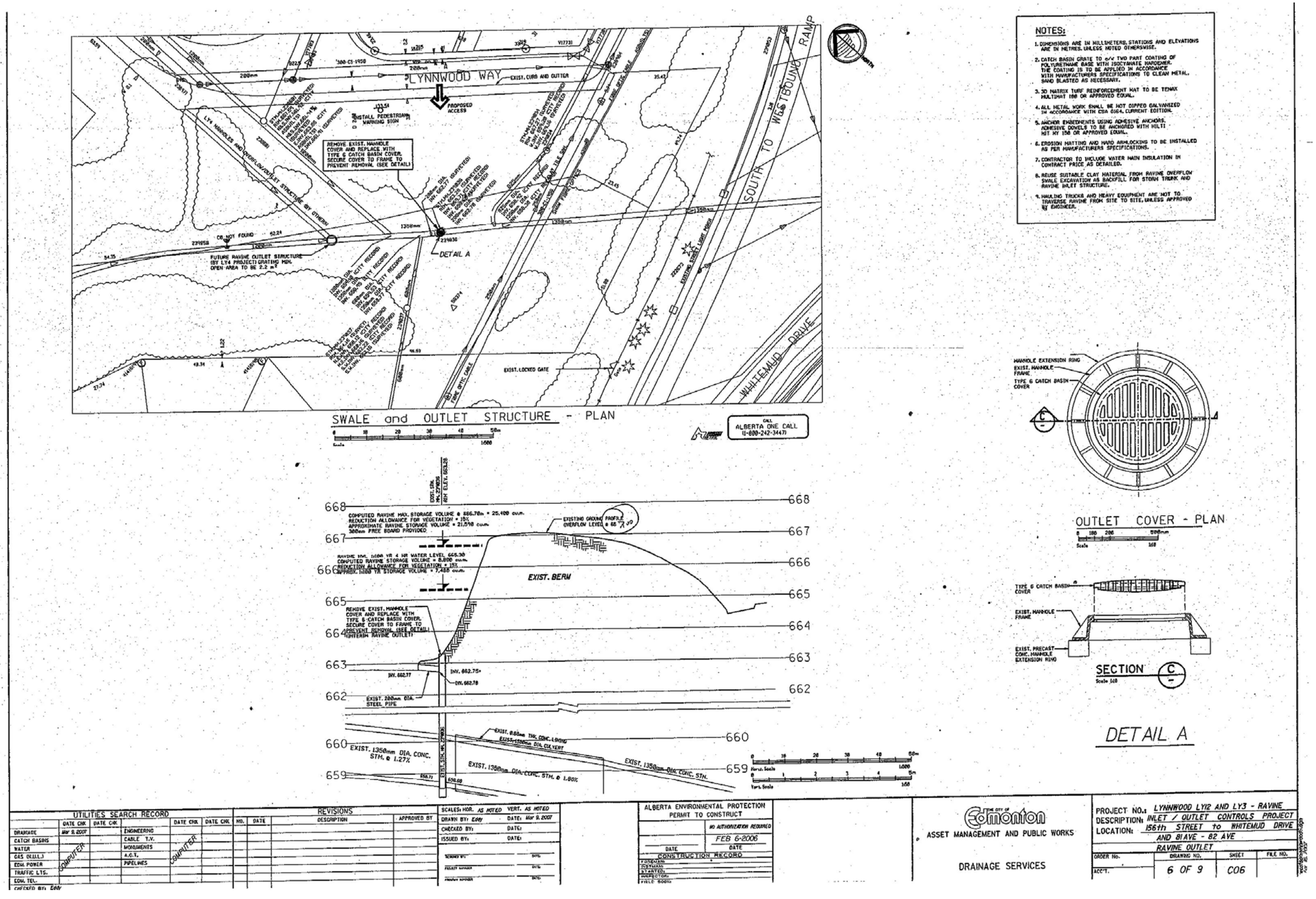


Figure 2-4: Water Level in Lynnwood Ravine With Different Size of Outlet (1:100 year 4 hour event)



NOTES:

1. DIMENSIONS ARE IN MILLIMETERS, STATIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
2. CATCH BASIN GRATE TO c/c TWO PART COATING OF POLYURETHANE BASE WITH ISOCYANATE HARDENER. THE COATING IS TO BE APPLIED IN ACCORDANCE WITH MANUFACTURERS SPECIFICATIONS TO CLEAN METAL, SAND BLASTED AS NECESSARY.
3. 3D MATRIX TURF REINFORCEMENT MAT TO BE TENAX MULTIMAT 150 OR APPROVED EQUAL.
4. ALL METAL WORK SHALL BE HOT DIPPED GALVANIZED IN ACCORDANCE WITH CSA G164, CURRENT EDITION.
5. ANCHOR EMBEDMENTS USING ADHESIVE ANCHORS. ADHESIVE DOWELS TO BE ANCHORED WITH HILTI HIT HY 150 OR APPROVED EQUAL.
6. EROSION MATTING AND HARD ARMLOCKING TO BE INSTALLED AS PER MANUFACTURERS SPECIFICATIONS.
7. CONTRACTOR TO INCLUDE WATER MAIN INSULATION IN CONTRACT PRICE AS DETAILED.
8. REUSE SUITABLE CLAY MATERIAL FROM RAVINE OVERFLOW SWALE EXCAVATION AS BACKFILL FOR STORM TRUNK AND RAVINE INLET STRUCTURE.
9. HAULING TRUCKS AND HEAVY EQUIPMENT ARE NOT TO TRAVERSE RAVINE FROM SITE TO SITE, UNLESS APPROVED BY ENGINEER.

DETAIL A

UTILITIES SEARCH RECORD

	DATE CHK	DATE CHK		DATE CHK	DATE CHK
DRAINAGE	Mar 9, 2007		ENGINEERING		
CATCH BASINS		COURIER	CABLE T.V.		COURIER
WATER			MONUMENTS		
GAS (U.I.L.)			A.G.T.		
EDM. POWER			PIPELINES		
TRAFFIC LTS.					
EDM. TEL.					

CHECKED BY: EAH

REVISIONS

NO.	DATE	DESCRIPTION	APPROVED BY

SCALES: HOR. AS NOTED VERT. AS NOTED
DRAWN BY: EAH DATE: Mar 9, 2007
CHECKED BY: DATE:
ISSUED BY: DATE:

ALBERTA ENVIRONMENTAL PROTECTION
PERMIT TO CONSTRUCT
NO AUTHORIZATION REQUIRED
FEB 6-2006
DATE DATE
CONSTRUCTION RECORD
FOREMAN
CONTRACTOR
STARTED:
COMPLETED:
FIELD BOOK:

THE CITY OF Edmonton
ASSET MANAGEMENT AND PUBLIC WORKS
DRAINAGE SERVICES

PROJECT NO.: LYNNWOOD LY12 AND LY3 - RAVINE
DESCRIPTION: INLET / OUTLET CONTROLS PROJECT
LOCATION: 156th STREET TO WHITEMUD DRIVE AND 81AVE - 82 AVE
RAVINE OUTLET

ORDER No.	DRAWING NO.	SHEET	FILE NO.
ACC'T.	6 OF 9	C06	

Figure 2.5 Lynnwood LY3/L13 Swale and Outlet Structure

2.3.5 Resource and Material Requirements

LY12 & LY3 Project
Materials required include the following:

- Trenching machine
- 1800 mm reinforced concrete pipe
- Clean gravel bedding material
- Pipe layer
- 3000 mm x 1500 mm box structure
- Grated box structure covers
- Clay fill
- Clean black top soil
- Shrubs, grass sod and/or grass seed mix

LY4 Project
Materials required include the following:

- Excavation equipment
- Equipment used in trenchless construction
- 1050 mm reinforced concrete pipe
- Clean black top soil
- Grass sod and/or grass seed mix

LY2A & LY5B Project
Materials required include the following:

- Excavation equipment
- Equipment used in trenchless construction
- 525 mm reinforced concrete pipe
- Clean black top soil
- Grass sod and/or grass seed mix

2.3.6 Waste Disposal

All construction materials will become the property of the contractor. Methods to be used for waste disposal will be at the discretion of the contractor and cannot be detailed at this time, however, the contractor will be responsible for waste disposal in conformance with environmental regulations.

2.3.7 Key Project Activities

2.3.7.1 Site Preparation Phase

LY12 &LY3 Project
Site preparation activities include the following:

- Hydrovac services to locate the exact position of the existing 1200mm storm pipe.
- Relocation of 4-5 (3-4 m tall) spruce that will interfere with the trenching operation.
- Stockpiling and/or removal of existing sod and soil.

LY4 Project
Site preparation activities include the following:

- Hydrovac services to locate the exact position of the existing crossing sewer pipes.
- Removal of several (number unknown at this time) trees which would interfere with the construction of the open vertical shafts required for trenchless construction.
- Stockpiling and/or removal of existing sod and soil.

LY2A & LY5B Project
Site preparation activities include the following:

- Hydrovac services to locate the position of the existing sanitary sewer line.
- Removal of several (number unknown at this time) trees which would interfere with the construction of the open vertical shafts required for trenchless construction.
- Stockpiling and/or removal of existing sod and soil.

2.3.7.2 Construction Phase

LY12 & LY3 Project
Construction activities are as follows:

- Use of the open caged trenching method to remove the existing pipe and install the new pipe.
- Open cut excavation (with minimum 1:1 slopes) at the tie-in locations for the outlet structure and the inlet structure.
- Installation of the inlet/overflow structure.
- Removal of topsoil in the ravine area down-slope from 156th Street to the inlet structure during the grading of the disturbed area from trenching.
- Relocation of 4-5 small (3-4 m tall) spruce trees which are currently located on the site to be used for the inlet structure and along the planned line for the open trenching operation.
- Installation of outlet pipe opening to be completed with the new manhole connection to the existing 1350mm pipe under the ravine with the LY4 project.
- Re-grading of the ravine surface for 30 m from 156th Street to the inlet structure, and then for an additional 40 m from the inlet structure to the new 2400 mm diameter manhole.

LY4 Project
Construction activities are as follows:

- Drilling of two (perhaps three) large vertical shafts as initiation and reception points for trenchless construction methods for equipment and/or hand-tunnel access points. For the

vertical shaft located within the ravine, it will be drilled first, and then hand excavated to the required depth.

- Installation of a manhole connection at the end of the Main ravine to the existing 1350 mm pipe under the ravine. A grated manhole cover will be incorporated to be used as an additional outlet opening for the LY3 Project..

LY2A & LY5B Project
Construction activities are as follows:

- Sharing of the two (perhaps three) large vertical shafts (the same shafts that are to be drilled for the LY4 project) as initiation and reception points for trenchless construction equipment and/or hand-tunnel access points.
- Potential open cut construction to connect the new relief sanitary sewers under the LY2A & LY5B Projects.

Note: the LY5B project is not part of this ESR but will be constructed at the same time with LY2A.

2.3.7.3 Reclamation Phase

Site reclamation for the LY3 & LY12 project will consist of filling the open trench with clean clay fill and landscaping the ravine surface with clean topsoil. This soil layer will be graded and sodded immediately after construction so as to protect the disturbed area from soil erosion. Site reclamation for the LY4 and LY2A projects will consist of filling the open working shafts with clean clay fill and landscaping the ravine surface with clean topsoil. The disturbed side slopes of Lynnwood Ravine will also require erosion control measures due to the potential operational processes occurring on them and the slope angles which are steeper than 5:1.

All proposed landscaping plans will be subject to approval from the City of Edmonton Parks Branch of Asset Management & Public Works (AMPW).

2.3.8 Project Schedule

LY12 & LY3 Project
Construction is scheduled for the Fall of 2007. The exact date will be determined by the selected contractor's schedule and by weather. The exact duration of construction is not known and will be influenced by the contractor's schedule. The tentative construction schedule is from late August to early November of 2007 in order to complete the work after the summer season of major rainfall events has passed.

A review of the climate normals for the Edmonton region revealed that the lowest rainfall levels during the summer season occur in Edmonton during August, with significantly lower levels in September (Appendix A). Mean daily rainfall levels during the month of August (for the period of 1970-2006) indicate that there is an appreciable decrease in the amount of rainfall after 17 August (Appendix A).

LY4 and LY2A & LY5B Projects

Construction is scheduled for 2008. The exact date will be determined by the selected contractor's schedule and by weather. The duration of construction is not known and will be influenced by the contractor's schedule. The tentative construction schedule can be started as early as Spring 2008 with tunneling operations continuing up to the winter months. Any open cut within the ravine should be done after the summer season of major storm events (about the middle of August 2008).

2.3.9 Construction Working Hours

Construction will not extend beyond the hours permitted in the City's Noise Abatement Bylaw 7255 (0701 – 2200 hours), unless special permission is granted by the City following standard protocols for exceptions to the Bylaw.

2.3.10 Construction Working Areas

This assessment assumes that most construction activity will occur in relatively restricted sites, either as:

- a narrow trenching operation within the Main ravine,
- narrow (2.5 m) regrading & sodding operations from the curb cut at 156th Street
- vertical shafts for microtunelling or hand-tunneling in the Main and Small ravines,
- specific sites for installation of the LY3 inlet/overflow structure, enlarging the outlet pipe in the Main ravine by changing the existing manhole cover to a grated cover and providing another grated cover at the LY4 connection to the existing ravine pipe system.

LY12 & LY3 Projects

The laydown area for construction equipment will be on the grassy area adjacent to the east side of 156th Street on the north side of the ravine.

LY4 and LY2A Projects

Two construction laydown areas have been identified:

- On the manicured grass along the boulevard at the corner of 152nd Street and 83rd Avenue.
- On the manicured grass along Lynnwood Way at the end of 81st Avenue.

2.3.11 Construction Staging Areas and Access

LY12 & LY3 Projects

Reserves of imported clay and topsoil for backfill material for the pipeline trench will be trucked-in and installed as soon as pipe installation is complete. The potential stockpile area will be in the same general area of the laydown area, in the grassy area adjacent to the east side of 156th Street on the north side of the ravine.

Access to the Lynnwood Ravine for the pipe and overflow structure installation, and swale grading will be via the west end of the Main ravine at 156th Street.

LY4 and LY2A Projects

The working shaft for trenchless construction operations will be located in the middle of 83rd Avenue at 152nd Street. The reception shaft will be in the Main ravine, which can be accessed from the adjacent Lynnwood Way. However, if this route proves too steep for motorized vehicles without causing significant surface damage, vehicles can drive the entire length of the Main ravine from 156th Street.

Two construction laydown areas will be used: at the junction of 83rd Avenue and Lynnwood Way and along Lynnwood Way at 150th Street. Both sites will be located on manicured grasslands.

2.4 Alternatives Considered

Several means for constructing both the LY3 and LY4 components were considered before deciding on the preferred designs. This included Value Engineering, Constructability and Risk Assessment Workshops for different construction scenarios. The results of the Value Engineering , Constructability and Risk Assessment Workshops for LY3 and LY4 storm system improvement projects can be found in Appendices B and C respectively. The alternative options are described below as well as a rationale for their dismissal.

LY3 Project – Storm Pipe

Option 1 – Trunk Upgrade

Option 1 would involve upgrading the existing 1200 mm storm trunk line to an 1800 mm line with greater capacity and extend this new, larger pipe 162 m to the east of 156th Street, the end of which would be the location of the overflow structure. Preliminary cost estimates for this option were approximately $386K.

Option 2 – Twinning

Option 2 would involve constructing a new 1350 mm pipe adjacent to the existing 1200 mm pipe, from 156th Street to the overflow structure 162 m to the east, thereby increasing conveyance and storage capacity. A MOUSE simulation showed that this scenario was as effective at stormwater removal as Option 1. A CCTV inspection of the 1200 mm pipe performed by the City of Edmonton found that this pipe, which was installed in 1967, was still in good condition making this option technically feasible. An additional benefit of this option was that that the existing pipe could remain in place during construction of the new pipe in order to handle storm flows that might occur during construction. Preliminary cost estimates for this option ranged from approximately $351K using a caged trench construction method to $341K for open cut trenching.

Options 1 and 2 were both dismissed because of the increased surface disturbance involved in the Main ravine in order to construct them.

Option 3 - Partial Storm Water Pipe Extension and Ravine Bottom Re-shaping

Option 3 was a result of the Value Engineering and Risk Assessment-Constructability session. A length of 42 m was set at a minimum pipe replacement to minimize disturbance/excavation

further along the ravine but would result in the removal of several large (8-9 m) mature trees by the proposed regrading of the ravine bottom. Preliminary cost estimates for this option were approximately $196K.

All of options 1,2 & 3 include regrading of the berm at the southeast end of the Main ravine to produce an overflow spillway, with resulting concentrated floodwater flows onto the Whitemud Freeway.

Option 4 – Modified Option 3
This option is a modification of Option 3 which includes a curb cut along 156th Street (as described previously for the LY12 project) and ravine regrading to allow overland flow from 156th Street directly into the ravine, with additional catchbasins to direct water flows immediately into the storm water pipe, thereby eliminating the need for providing the spillway onto the Whitemud Freeway. The rationale for option 4 is the provision of a 1.9 m freeboard from the highwater level to the lowest lot elevation abutting the ravine, coupled with enlarging the outlet opening from 200 mm to 1200 mm, thus reducing the retention time of flood waters in the ravine. This option also has a smaller disturbance footprint as compared to Option 3 and will maximize the retention of large trees in the ravine. The inlet/overflow structure into the ravine has also been relocated to minimize disturbance in the Main ravine. This is the option that is being carried forward by Drainage Services for construction.

Enlarging the outlet pipe opening draining the ravine is the same for all four options.

Option 4 also takes advantage of the fact that the elevation of the berm along the southeast end of the Main Ravine (which is 667.1 m asl) is 0.1 m lower than the lowest residentail lot adjacent to the ravine. In extreme cases where the larger LY3 pipe and the larger Main Ravine outlet opening is still not capable of draining the Lynnwood Ravine faster than it can be filled, the excess flood waters will spill over the berm and onto the Whitemud Freeway.

LY4 Project
Option 1 – Replacement of existing pipe
Option 1 was recommended in the conceptual design report. The existing 1200 mm pipe would be replaced by the new 1500 mm pipe.

To do the replacement by open cut, a trench approximately 6 m in depth would have to be excavated in order to remove the old pipe, then deepened to accommodate 500 mm of bedding for the new pipe. Preliminary cost estimates for this option were approximately $3.15 million. Problems associated with the open cut method include the following:

- The open trench would need to be shored or caged to minimize disturbance. This would be costly.
- Since the trench would be down the side of 152nd Street and this roadway is most likely built on fill, the top of the trench would probably widen due to slumping, creating additional surface disturbance.
- The water and sanitary services to approximately ten residences along 152nd Street would have to be disturbed, and interim servicing provisions put in place.

- Construction would need to be carried out during low flood periods to minimize problems associated with excess water.

To perform a trenchless replacement of the existing pipe, pipe-busting methods were considered. However, existing conditions made this a non-feasible option. Those conditions were as follows:

- The minimum depth of soil cover over the new storm trunk would not have been available for the entire length of the pipe.
- The diameter of the new pipe would have to be 1650 mm instead of the planned 1500 mm because the pipe bursting method could not change the grade of the pipe, therefore a larger diameter would be required to achieve the same level of storm water conveyance.
- The size of the new pipe is at the upper threshold for pneumatic pipe bursting.
- The newer pipe is three sizes greater than the existing pipe. Pipe bursting with size increase of three or more are quite difficult.
- There are several other buried services which could potentially be adversely affected by the pipe bursting process, including utility crossings, an existing 200 mm sanitary sewer with numerous sanitary service connections located directly above the storm trunk and a nearby water line.

For those reasons, option 1 was rejected.

Option 2 – Construction of twin pipe by open trench installation
For option 2, a trench 6.5 m in depth would need to be dug along the side of 152nd Street and into the Small/Main ravines. Preliminary cost estimates for this option were approximately $2.27 million. This would have resulted in significant traffic disruptions for the residents and loss of trees in the ravine.

For those reasons, option 2 was not pursued.

LY2A Project
The same problems which affected the caged open trench construction methods for the LY4 storm water line will also affect this sewer line, because the LY2A sewer line will be built in the same location and at a similar depth as the LY4 pipe.

In addition, the line was initially planned to parallel Lynnwood Way as the road turned to the southeast. It was decided to maintain a straight-line pipe twinning using trenchless construction method for LY4 would allow the LY2A and LY5B sanitary sewer to meet with the existing sewer trunk. However, the initial alignment has not been completely discarded since the trenchless methods are being pursued and could be used for both alignment options.

2.5 Environmental Permitting Requirements

Described below are the various federal, provincial and municipal environmental review and permitting processes applicable to the project.

2.5.1 Federal Government

2.5.1.1 Canadian Environmental Assessment Act

There is no need for any environmental review for the project pursuant to the CEA Act. That is because key environmental permits under such Acts as the Fisheries Act and Navigable Waters Protection Act are not required. Further, no federal lands are required to construct the project and no federal monies are being used to undertake the project.

2.5.1.2 Migratory Birds Convention Act

Environment Canada administers the *Migratory Birds Convention Act (MBCA),* which prohibits the disturbance of nests of bird species covered under the *Act* (primarily migratory birds). With respect to construction, the *Act* provides guidelines for enforcement only; it is not linked to formal approvals. Violation of the *Act* may, however, result in penalties. A recent amendment to the *MBCA* further protects disturbance to individual migratory birds and prohibits release of deleterious substances into waters or areas frequented by migratory birds. This ESR provides information that enables the proponent to comply with the *Act*, specifically by ensuring that direct mortality to birds and active nests does not occur as a result of the proposed project and by recommending best management practices that strive to avoid the deposit of deleterious substances in avian habitats.

2.5.1.3 Species At Risk Act

The *Species At Risk Act* (*SARA*) is administered by Environment Canada. It prohibits disturbance to listed species and, in some instances, listed species' habitat. Habitat is defined not only as the area where a species naturally occurs and on which it depends to carry out its life processes, but also areas where that species formerly occurred and has the potential to be reintroduced. As such, any species listed under the *SARA* that has potential to be present in the study area must be considered during the impact assessment process. Although the *SARA* emphasizes guidelines for enforcement, other agreements, permits and licenses may be required if a proposed activity is considered an offence under the *Act*. The potential to impact a listed species is addressed in this assessment so that such activities and their impacts can be mitigated through design and construction practices.

2.5.2 Provincial Government

The project was reviewed to determine the potential for triggering the Alberta Water Act. There is no need for Water Act approval and the project will be constructed under the City of Edmonton's existing license from Alberta Environment to manage its storm water management system.

There are no Alberta public lands involved pursuant to the Alberta Public Lands Act, so no approvals pursuant to that provincial act are required.

2.5.2.1 Alberta Wildlife Act

The Alberta *Wildlife Act* prohibits disturbance to a nest or den of prescribed wildlife species. Although permitting is not required under that *Act*, violations may result in fines. The potential to impact nests or dens is addressed in this ESR so that any such issues may be resolved through the project design.

2.5.2.2 Historic Resources Act

Any development with potential to disturb historical resources requires clearance by Alberta Community Development, pursuant to the *Historic Resources Act*.

2.5.3 Municipal Government

2.5.3.1 Parkland Bylaw

The City of Edmonton's newly revised Parkland Bylaw 2202 regulates the conduct and activities of people on parkland and protection of the environment in all City parks, including the North Saskatchewan River Valley. Pursuant to Bylaw 2202, disturbance to natural areas, utilization of construction lay down areas, interference with other park users and motor vehicle access are restricted. Upon approval of this project, an exemption to the Parkland Bylaw 2202 would be requested from the City Manager prior to beginning construction activities. A detailed Staging Area Agreement would be developed prior to beginning construction including hazardous materials storage, size and locations for staging areas and construction laydown areas, access by construction workers and the public, security, utilities hoarding, tree hoarding, public safety measures provided (fencing around open pits, etc) and construction staff parking.

2.5.3.2 North Saskatchewan River Valley Area Redevelopment Plan

Because the Lynnwood Ravine falls within the boundaries of the North Saskatchewan River Valley Area Redevelopment Plan, Bylaw 7188 requires that an environmental review of the project be completed. Edmonton Planning and Development, who administer Bylaw 7188 environmental reviews, determined that an Environmental Screening Report (ESR) level of assessment should be undertaken for the LY3, LY4 and LY2A projects.

2.5.3.3 City of Edmonton Corporate Tree Management Policy

All ornamental trees and natural treed areas on City-owned property are the responsibility of Edmonton Parks Branch of Asset Management & Public Works (including procurement, maintenance, protection and preservation) pursuant to the City of Edmonton's Corporate Tree Management Policy C456A. That policy states that where damage to, or loss of, City trees occurs, equitable compensation for that loss will be recovered from the entity causing the damage or loss and applied to future tree replacements.

3.0 METHODS

3.1 General Methods

Following are brief descriptions of the main methods and steps employed in the preparation of this ESR.

- Meetings were held with representatives of the City of Edmonton Planning and Development Department and Drainage Services with the engineering firms (Earth Tech and Sameng) to discuss the project and identify the appropriate level of environmental assessment, scope of work and issues to be addressed in this ESR.
- Public stakeholders were consulted through an open house process to identify potential environmental impact assessment issues.
- The study area was defined by the environmental consultant and the City of Edmonton, Design and Construction with the two consultants hired by the City (Earth Tech and Sameng).
- Reconnaissance level site assessments were conducted on 22 June and 6 October, 2006 to identify potential issues.
- A further field survey was undertaken on 18 October, 2006 to better delineate plant communities and assess topography and wildlife habitat.
- Valued Environmental Components (VECs) on which to focus the impact analysis were selected.
- Detailed information review, including mapping of resources, was undertaken.
- The following assessments conducted in the study area were reviewed:
    - Lynnwood LY3/L13 Ravine Inlet/Outlet Controls Project. DRAFT Preliminary Design Report. Prepared by Earth Tech.
    - Lynnwood LY4 Storm Trunk Upgrading. Draft Preliminary Design Report. Prepared by Sameng.
    - Conceptual Design Sanitary addendum (for the LY2A and LY5B Sanitary Sewer Relief lines) to the previous publication.
- Potential impacts were identified, analyzed and rated according to direction, magnitude, duration and predictability.
- Relevant information was obtained from two Risk Assessment and Value Engineering Workshops held with all interested parties: on 11 October, 2006, for LY3, and 21 September, 2006, for LY4, LY2A and LY5B.
- Alternative construction approaches and locations of construction support were evaluated.
- Appropriate mitigation measures to minimize adverse effects and enhance positive effects were developed.
- A draft report was prepared and submitted to Earth Tech and Sameng for review and comment. It was then submitted to Edmonton Drainage Services and other review agencies.
- A final report reflecting all comments will be resubmitted to Edmonton Planning and Development for their review and sign-off.

3.2 Detailed Methods

The following sections describe in more detail the approach used in preparing this ESR.

3.2.1 Scoping the Assessment

The assessment scope confirms the assessment process and key regulatory stakeholders to be involved in a given project. Scoping determines the level of assessment, identifies the specific issues to be addressed (including permitting requirements), and establishes the spatial and temporal boundaries of the study area. The steps involved in scoping the assessment for this project are outlined in the sections below.

3.2.1.1 Jurisdiction

The LY12 & LY3, LY4 and LY2A & LY5B projects will occur within the Lynnwood Ravine, a property which is under the jurisdiction of the City of Edmonton.

3.2.1.2 Level of Assessment

This was determined early on through discussions between Drainage Services, Design and Construction, Earth Tech, Sameng and the City of Edmonton Planning and Development Department. It was determined that the above-mentioned projects fell within the North Saskatchewan River Valley Area Redevelopment Plan and that construction activities would potentially impact both the natural setting of the Lynnwood Ravine and the public areas adjacent to the ravine. It was further determined that public awareness in the project had been generated from public consultation sessions that were initiated during the planning phase of the projects. On the basis of that information, it was determined by Edmonton Planning and Development that an Environmental Screening Report (ESR) level of assessment was appropriate.

3.2.1.3 Issues Identification

ESR issues were identified through the following means and sources:

- Meetings were held with project management staff to obtain a fundamental understanding of the project's design and construction considerations and to identify regulatory concerns.
- Bylaw 7188 environmental review guidelines were reviewed.
- Reconnaissance level site inspections were undertaken on several occasions throughout summer and autumn of 2006.
- A reconnaissance level vegetation survey was undertaken on 18 October, 2006.

From those sources, a list of issues was developed, which helped refine the broad Terms of Reference set out in the ARP environmental review process guidelines. The list also provided a starting point to identify VECs for the ESR. Note that issues identified in this process are potential concerns. The extent to which a concern is real is confirmed through the impact assessment process. In some instances, a perceived concern may not be realized by project activities, but once identified it must still be analyzed and characterized to satisfy the requirements of the impact assessment process.

3.2.1.4 Spatial and Temporal Boundaries

Spatial and temporal boundaries appropriate to the resource were selected to help focus the assessment on an area/timeframe most likely to be affected by the proposed project. In this way, the assessment is specific to the project and the resource. The ESR focused on the area identified in Figure 1.2, although in some instances this area was expanded or contracted for specific Valued Environmental Components (VECs). Where deviations were used, they are mentioned in the description of existing conditions.

3.2.2 Selection of Valued Environmental Components

No assessment can be so broad in scope that it investigates potential impacts on all components of the natural, social and heritage environments. To be effective, investigations must focus on selected environmental features that are considered most important within the context of the proposed development. Three types of Valued Environmental Components (VECs) were identified:

- **Valued Ecosystem Components**: species or features of the natural environment.
- **Valued Socio-Environmental Components**: features of human settlement / development or cultural values.
- **Valued Heritage Components:** sites, artifacts or structures of our natural and human history.

VECs were selected based on five criteria:

- relative abundance or status,
- public concern,
- professional concern,
- economic importance,
- regulatory concern.

Relative abundance or species status refers to those resources within the study area that are considered rare, threatened or endangered at a provincial or national level. It can also include those resources that have a limited distribution or abundance within the local or regional study area.

Resources of public concern include attributes or features that were raised as issues by the public during public consultation. Professional concerns are related to those features of the environment known to be critical for sustaining the ecosystem, or maintaining social or heritage values within the affected site. Resources of economic importance are various and range from aesthetic values important for tourism to sport fisheries.

Lastly, features of regulatory concern apply to resources that have been identified as special concerns by provincial or federal regulatory agencies. These could include parkland and associated tree cover, and/or and rare or migratory species, depending on the project type and

location. Selected VECs and the justification used for their selection for this project are listed in Table 3.1.

Table 3.1 Justification for Selection of VECs

Valued Environmental Components	Relative Abundance or Status	Public Concern	Professional Concern	Economic Importance	Regulatory Concern	Trigger for Inclusion
Valued Ecosystem Components						
Soils/Geology/ Geomorphology/Terrain		√	√		√	• Bylaw 7188
Hydrology and Surface Water Quality			√		√	▪ Bylaw 7188
Air Quality		√	√			▪ Activities with potential to degrade air quality
Vegetation • Native vegetation • Rare species	√	√	√		√	• Bylaw 7188 • Federal *Species at Risk Act* • Edmonton Corporate Tree Management Policy C456
Wildlife • Habitat • Rare species	√	√	√		√	• Bylaw 7188 • Federal *Species at Risk Act*, *Migratory Birds Convention Act* • Alberta *Wildlife Act*
Valued Socio-Environmental Components						
Land Disposition and Zoning				√	√	▪ Bylaw 7188
Utilities		√	√	√	√	▪ Bylaw 7188
Land Use • Recreational Land Use		√	√		√	▪ Bylaw 7188
Worker and Public Safety		√	√	√	√	▪ Bylaw 7188
Visual Resources		√	√		√	▪ Bylaw 7188
Valued Heritage Components						
Historical Resources			√		√	▪ Alberta *Historic Resources Act*

Fish and aquatic resources were not included as a VEC because there is no stream within the project area and the closest the ravine comes to any stream (the North Saskatchewan River) is approximately 900m.

3.2.3 Description of Existing Conditions

The description of existing conditions provides a current snapshot of the project area, over which the proposed project can be superimposed to identify areas of potential concern. For Edmonton's river valley and associated ravines (of which the Lynnwood Ravine is a component),

environmental conditions are well-documented. A biophysical assessment conducted by EPEC Consulting Western Ltd. (1981) provides a comprehensive overview of the river valley that has been used in numerous EIA's for projects within the City's river valley.

That information base, supplemented by observations made during the site reconnaissance visits and a vegetation survey, was used to develop the general descriptions of existing conditions. Specific methods used to describe the existing conditions vary slightly with each VEC, and so are described in the respective sections of Chapter 5.

3.2.4 Impact Analysis

Impact analysis is the final step in confirming the likelihood and severity of a potential effect of the project on the environment. In this step, concerns raised by the public, regulators and environmental scientists are evaluated with respect to the existing environmental conditions and characterized so that their significance can be assessed by the regulatory authorities responsible for the environmental assessment process. While some potential impacts might eventually be determined to be negligible, the potential interaction of a VEC with a given project activity must be described and documented in order to resolve the original concern. Impact analysis, therefore, involves a statement of the potential effect, followed by a description of the means by which the VEC may be affected, or remain unaffected, by the project. Lastly, the impact is characterized in terms of standardized descriptors to allow a reviewer to evaluate the significance of project effects. The various stages of impact analysis are outlined in more detail below.

3.2.5 Impact Identification

To identify ways that the proposed project could affect VECs, potential interactions between the project activities and VECs were identified through professional judgment and discussions with the proponents. They were then assessed with regard to the type of change that would occur in the VEC and existing environment as a result of the interaction. For example, potential effects resulting from the interaction of construction access on residential land use.

3.2.6 Impact Description Characteristics

For each potential interaction identified, the extent and likelihood of the impact was then described and characterized. The characteristics used to describe impacts for this project were based on the requirements of the applicable municipal, provincial and federal environmental legislation.

Based on these guiding pieces of legislation, impacts were described and classified as to their magnitude/severity (negligible, minor, or major), direction (positive or adverse), duration (temporary or permanent) and confidence in impact prediction (predictable effect/unknown effect). These criteria were defined follows:

Magnitude:

Negligible Impact: An interaction that is determined to have essentially no effect on the resource. Such impacts are not characterized with respect to direction, duration or confidence.

Minor Impact: An interaction that has a noticeable effect but does not affect local or regional populations, natural or historical resources or physical features beyond a defined critical threshold (where that exists) or beyond normal limits of natural perturbation. Also, an interaction that does not alter existing or future recreational pursuits at established facilities or well-used areas.

Major Impact: An interaction that affects local or regional populations, natural or historical resources, or physical features beyond a defined critical threshold (where that exists) or beyond the normal limits of natural perturbation; or alters existing or future recreational pursuits at established facilities or well-used areas.

Direction:

Positive Impact: An interaction that enhances the quality or abundance of physical features, natural or historical resources, or recreational pursuits or opportunities.

Adverse Impact: An interaction that diminishes the abundance or quality of physical features, natural or historical resources, or recreational pursuits or opportunities.

Duration:

Short-term Impact: An interaction resulting in a measurable change that does not persist for longer than one year post-construction.

Long-term Impact: An interaction resulting in a measurable change that persists longer than one year post-construction but at some point dissipates completely.

Permanent Impact: An interaction resulting in measurable change that persists indefinitely.

Confidence:

Predictable Impact: Effects are well understood through experience with projects of a similar nature.

Uncertain Impact: Effect on VEC is not well understood owing to lack of knowledge of the VEC and/or its response to disturbance in similar circumstances.

Project interactions presenting a risk to worker and public safety were not always characterized using the above definitions. They were instead assessed in terms of the degree of perceived risk (i.e., minimal *vs.* high risk). In some cases, the potential impact resulting from the interaction was then characterized according to the above definitions.

3.2.7 Initial Impact Assessment and Mitigation Development

All identified project interactions were analyzed and described according to the characteristics defined above. Features of the project activities that would reduce the degree of impact, such as best management practices in erosion control, were reviewed at this stage, and used to assign the degree of impact.

In the next step of the assessment, mitigation measures other than those built into the project description were developed to address impacts that, if not addressed, would have an undesirable degree of impact on the VEC. All attempts were made to reduce impact severity; however, this is not always feasible or practical. For less severe impacts, mitigation measures were proposed if they were considered cost-effective and/or worked in concert with other proposed measures.

3.2.8 Residual Impact Assessment

Any effect remaining after mitigation is termed a residual impact. For the final stage of the assessment, residual impacts were classified according to the impact characteristics described above with one exception - impact rating confidence used the following descriptors:

> **Predictable Residual Impact:** Efficacy of proposed mitigation measures is well understood through application in similar projects or circumstances.
>
> **Uncertain Residual Impact**: Efficacy of mitigation measure is not well understood because of a lack of previous experience in similar circumstances or lack of knowledge about the VEC.

3.3 Public Consultation

In February, 2005, the West Edmonton Flood Relief Conceptual Design Report was completed. It found that 43 Edmonton communities were at risk from future flooding and it designated 15 of them as high priority communities due to the extent of flooding experienced by those communities during the 2004 severe storm event. The report analyzed the locations of floods, examined water flow for both underground and surface water, identified weaknesses in the current stormwater drainage system, and developed a series of options for improving the drainage drainage system within each community.

The results from the West Edmonton Flood Relief Conceptual Design Report were presented to the public through a series of community consultations run by the City of Edmonton Drainage Services Department. The public consultations specific to the Lynnwood Ravine are described below.

05 April 2005
Location: Lynnwood Hall
Public attendance: 85
Main presenter: Douwe Vanderwel, Senior Engineer & Flood Prevention Project Leader for Ward 1 - Drainage Services, City of Edmonton

The public presentation concentrated on:

- the effects of the July, 2004 storm;
- the findings of the West Edmonton Flood Relief Conceptual Design Report; and
- a proposal for directing stormwater into the Lynnwood Ravine and using the ravine to divert water away from the Lynnwood neighbourhood and into the North Saskatchewan River.

21 November 2005
Location: Lynnwood School
Public attendance: 28
Main presenter: Douwe Vanderwel, Senior Engineer & Flood Prevention Project Leader for Ward 1 - Drainage Services, City of Edmonton

The recommendations made by at this meeting included the following:

- Building a new sanitary sewer line from 79A Avenue to 87th Avenue along 152nd Street. It would be connected to the 87th Avenue main trunk.
- Building a new storm sewer line along 80th Avenue from 158th Street to 159th Street and divert the flow south to the Quesnell Storm Trunk along Whitemud Drive.
- Re-grading selected streets to improve surface drainage and direct more water to the Lynnwood Ravine. Improvements would be made to the ravine to get water to move through the ravine to the North Saskatchewan River more quickly. This would be done by increasing the outlet drain size to the Quesnell Trunk.

04 July 2006
Location: Lynnwood Hall
Public attendance: 84
Representatives from Drainage Services:

- Douwe Vanderwel, Senior Engineer & Flood Prevention Project Leader for west Edmonton, Drainage Services, City of Edmonton
- Derek Melmoth, General Supervisor, Public Services, Drainage Services
- Chris Ward, Director of Planning, Drainage Services

Two main system upgrades planned by Drainage Services to reduce the future risk of flooding in Lynnwood were proposed:

- Build a new sanitary sewer line from 79A Avenue to 87th Avenue along 152nd Street. It would be connected to the 87th Avenue tunnel.
- Increase the size of the Lynnwood Storm Trunk at two locations, to increase the size of the Lynnwood Ravine outlet drain so that the ravine will drain more quickly and construct an overflow spillway to prevent water levels from reaching the same high level as they did after the July 2004 storm.

09 November 2006
Location: Lynnwood Community
Public attendance: 48

Presentation materials covering the engineering and environmental aspects of both the LY3 and LY4 projects (posters, maps, airphotos, engineering figures, habitat map) were made available for public perusal by representatives from:

- City of Edmonton Drainage Services Department
- Earth Tech
- Sameng
- Spencer Environmental

The open house was advertised to the residents of Lynnwood Community in the following ways:

- A mail-out to a list of concerned citizens provided by the City (done about two weeks before the open house).
- A mail drop done by the Scouts on 2 November to every residence in Lynnwood (except Whitehall Square), for a total of 777 residences.
- A community league sign.
- Posters at the Lynnwood Community Hall, Lynnwood Elementary School and Whitehall Square Apartments.
- An announcement in the Lynnwood Elementary School newsletter.

Forty-eight people attended the open house, almost all of whom lived in the immediate neighbourhood of the Lynnwood Ravine. Eight individuals filled in comment forms in response to two questions on the forms directly related to the environment of the ravine and potential environmental impacts. There were only a few concerns expressed about the projects but none of raised any serious environmental issues.

A more detailed summary of comments received are provided in Appendix D.

4.0 KEY ENVIRONMENTAL AND SOCIO-ENVIRONMENTAL ISSUES

The North Saskatchewan River Valley is considered a sensitive natural feature in the City of Edmonton, supporting a variety of wildlife habitats, plant communities and unique environmental features. Although the Lynnwood Ravine has previously been disturbed by the installation of the original stormwater trunk, the construction activities required to install the new stormwater and sewer pipes have the potential to disturb the adjacent natural environment.

These possible disturbances provide a focus for this ESR, highlighting areas that should be addressed within the assessment. The concerns identified by the public and the ESR assessment team are outlined below. For each resource, a description of the potential issue is provided, followed by specific concerns in the form of questions.

4.1 Environmental Issues

4.1.1 Geology/Geomorphology

It is possible that a significant amount of water may collect in the ravine as a result of a severe storm event such as the one which occurred on 11 July, 2004.

- **In the event of the ravine being filled with water as a result of a severe storm, will there be significant erosion of the ravine side slopes?**

4.1.2 Soils

Concerns related to soils include risk of erosion, the potential for soil contamination and the possibility that the soil in the ravine bottom is already contaminated, as it was brought into the ravine as fill from an unknown source.

- **Will construction result in the loss of topsoil, or degrade soil quality, in turn affecting reclamation?**
- **Will use of staging areas for fuel, lubricants and other contaminants pose a risk of soil contamination?**
- **Will construction equipment result in soil compaction along temporary access routes?**
- **Will there be a problem with disposal of extracted soil due to possible contamination of that soil as a result of it being previously imported for fill in the ravine bottom from a contaminated source?**
- **If there is a severe rainstorm during construction, would significant amounts of loose sediment at the surface flow into the storm drainage system and then into the North Saskatchewan River?**
- **In the event of a severe storm, will surface water flowing out of the proposed LY3 inlet/overflow structure result in serious surface erosion further down the Lynnwood Ravine?**

4.1.3 Hydrology and Surface Water

As there is no surface drainage in either ravine, there are no issues regarding disrupting a watercourse. However, flowing water at the surface could be present during a severe storm event. Those concerns are dealt with in the previous section on soils.

- **Will homes adjacent to the Lynnwood Ravine experience less flooding than previously?**
- **Will sewers back-up less than previously?**
- **In the event of a severe storm, will surface water stored in the Lynnwood Ravine drain from the ravine faster than previously?**

4.1.4 Air Quality

- **Will dust generated by construction traffic and construction activities pose a health risk to residents and nearby recreational users?**

4.1.5 Vegetation

Several stands of native vegetation occur in the project area.

- **Will the project result in significant disturbance to native vegetation communities?**
- **Does the project have potential to affect rare, threatened or endangered plants or unique vegetation communities?**
- **Will disturbance to the surface vegetation result in a significant increase in the ability of invasive or noxious weeds to become established within the ravine?**
- **Will native or ornamental trees on City lands be removed or damaged during construction? How will any loss be compensated for as required by the Corporate Tree Management Policy?**

4.1.6 Wildlife

Wildlife habitat is present in the study area. Potential impacts to wildlife are related to habitat loss and alienation, noise, activity and human disturbance as a result of construction.

- **How much existing wildlife habitat will be removed for the project and what types of habitat?**
- **Will any rare, threatened or endangered wildlife be affected by construction activities?**
- **Will construction activity within the two ravines result in alienation of wildlife?**
- **Will wildlife movement be blocked or impeded by construction activities?**
- **Will construction activities affect breeding success?**

4.2 Socio-Environmental Resources

4.2.1 Land Disposition and Zoning

The proposed project is the responsibility of the City, however, there is some question about exactly which government is the legal owner of the Lynnwood Ravine lands.

- **Is this project occurring on City owned property?**

- **Will land zoning changes or easements be required?**
- **Will any additional lands be required to construct the project?**

4.2.2 Utilities

Several utilities are present within the study area. Specific issues include:

- **Will any utilities be damaged, resulting in a risk to public safety?**
- **Will any utilities be removed or realigned?**

4.2.3 Land Use

The Lynnwood Ravine is used as an informal recreational area by the nearby residents.

- **Will recreational users be affected by construction activities?**
- **Will traffic disruption, including traffic lane closures, be acceptable to motorists?**
- **Will construction activities damage roads used for construction access?**
- **Will construction activities result in damage to the landscape of the ravines?**

4.2.4 Worker and Public Safety

- **Is there potential for staging and construction areas to compromise the safety of motorists?**
- **Will construction increase the risk of wildfires occurring? Will fire fighters have access to all areas of the ravines?**
- **Is there a potential risk for pedestrians to fall into vertical working shafts?**

4.2.5 Visual Resources

Construction activities and the installation of new stormwater drainage structures could affect the natural landscape of the ravines.

- **How will construction activities and the installation of drainage structures affect the visual quality of the ravines?**
- **How will landscaping affect the visual quality of the ravines?**

4.3 Heritage Resources

Excavation will be required to expose the existing pipe and install the new pipe, to a depth of about 3m. With any construction project involving excavation there is a possibility of disturbing previously unidentified historical resource artifacts.

- **Will previously undiscovered artifacts be disturbed during subsurface construction activities?**

5.0 EXISTING CONDITIONS

5.1 Environmental Resources

5.1.1 Geomorphology/Terrain

5.1.1.1 Methods

The geology and geomorphology of the North Saskatchewan River Valley and Ravine System (NSRV) is described in several documents, including a biophysical inventory and analysis of the NSRV and Ravine System conducted by EPEC Consulting Western Ltd. (1981) and an overview of the geology of the Edmonton area prepared by the Edmonton Geological Society (Godfrey 1993).

Terrain and geomorphological information for the Lynnwood Ravine was obtained from technical information supplied by geotechnical specialist consultants to Earth Tech and Sameng Inc.

5.1.1.2 Description

Regional

The NSRV and its associated ravines is the most obvious geomorphological feature of the Edmonton area. The valley and ravine system was formed as a result of vertical downcutting and lateral river meandering (EPEC Consulting Western Ltd. 1981). It is underlain by bedrock of the Upper Cretaceous Horseshoe Canyon Formation (Godfrey 1993, EPEC Consulting Western Ltd. 1981) that generally consists of interbedded, grey clayey and silty shale, grey sandstone, bentonitic sandstone, bentonitic shale, coal and bentonite (EPEC Consulting Western Ltd. 1981).

Surficial materials in the river valley, from oldest to youngest, include:

- preglacial Saskatchewan gravels and sands;
- glacial till, outwash and lacustrine deposits; and
- postglacial or recent alluvial and colluvial materials (EPEC Consulting Western Ltd. 1981).

Aquifers in the river valley are associated with the deeper preglacial Saskatchewan gravels and sands (EPEC Consulting Western Ltd. 1981).

Local

The Lynnwood Ravine is a shallow angled, wide-bottomed ravine. The ground slope of the upper portion of the Main ravine is a very low 1.5% and the lower reaches of the ravine are almost level (Plate 1). The ground slope along the Small ravine is approximately the same except near where Small ravine merges with Main ravine at which point the slope is approximately 10°-12° (Plate 2).

Plate 5.1 Looking west along the Main ravine.

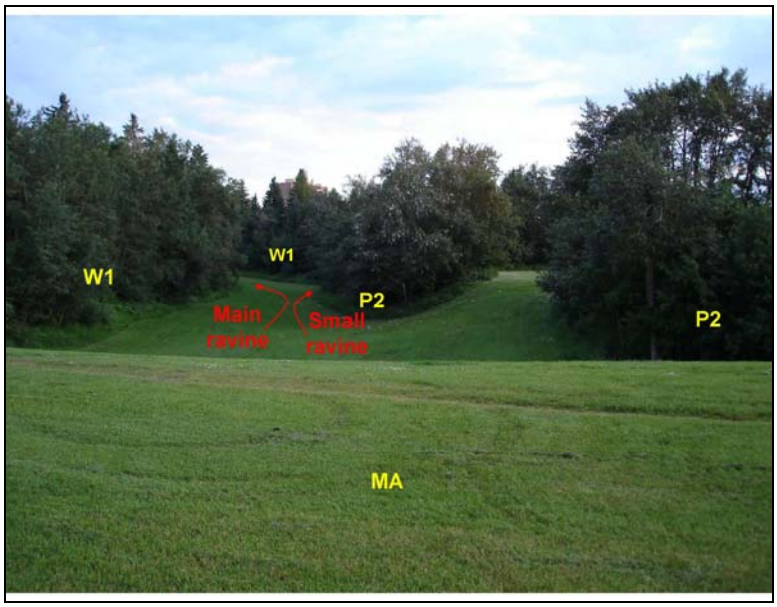


Plate 5.2 Junction of Small and Main ravines
(Yellow labels are specific plant communities. See Section 5.1.5).

The side slopes of Main ravine range from 12° to 22°, with most of the slopes at around 15°. The side slopes of Small ravine are very low angled, until close to Main ravine at which point the slopes are about 19° to 21°. The sides slopes for Main ravine are not uniformly sloped but have sections of both steeper and more gentle slopes.

There are two openings along the side slopes of the Main ravine for pedestrian footpaths. They were covered with small-sized aggregate material on 12° to 15° slopes and both are showing signs of significant washing of this aggregate material down into the ravine bottom.

5.1.2 Soils

5.1.2.1 Methods

Main Ravine
The soils were investigated by Thurber Engineering (Thurber Engineering 2006) who placed three test holes in the center of the Main ravine on 24 July 2006. The holes were drilled to a depth of approximately 10.4m and soil samples were collected for laboratory analysis and performing standard soil penetration tests.

Small Ravine
The soils were investigated by EBA Engineering Consultants (EBA Engineering Consultants Ltd. 2006), who placed five test holes at various sites within the Small ravine on 31 July and 9 August 2006. The holes were drilled to a depth of approximately 7.3 m and soil samples were collected for laboratory analysis and performing standard soil penetration tests.

5.1.2.2 Description

Main Ravine
The surface of the ravine bottom is composed of a layer of topsoil ranging in thickness from 5.0 cm to 20.0 cm. Beneath this topsoil, and down to a depth of 2.0-2.5m, is a very dark-coloured layer of stiff clay and silty-clay, with occasional lenses of sand (Table 5.1). It is believed that this represents a disturbed layer of fill (from an unknown location) as this clay layer is not uniform in composition but contains some randomly distributed pockets of whitish silt, some pebbles, and occasional deposits of fine-grained sand (0.7m thick) which contain small clay lumps. Pieces of junk metal and glass were also found in this layer.

Two of the three test holes found a 2.0 m to 3.4 m layer of brownish clay beneath the surficial clay fill. Because this layer had only traces of silts and sands, it is likely an undisturbed layer of glaciolacustrine clays. Beneath this layer and down to the bottom of the test holes, the soils consist of alternating layers of hard, brown clay tills and compact, grey to brown fine grained sands.

Table 5.1 Soil types in the upper soil horizons of the Main ravine

Borehole	Soil type	Depth below surface (m)
1	Clay fill	0.1 – 2.0
	Clay	2.0 – 4.0
2	Clay fill	0.2 – 1.8
	Sand fill	1.8 – 2.5
	Clay till	2.5 +
3	Clay fill	0.2 – 1.8
	Clay	1.8 – 5.2
	Sand	5.2 – 5.2

Detailed soil data for the Main ravine can be found in Appendix E.

Small Ravine

Boreholes 1, 2 and 3 all indicate the presence of clay or sand fill in the top 1.0 m to 2.5 m of the soil profile, a condition which is consistent with the soils in the adjacent Main ravine (Table 5.2). Borehole 1 was located in the Main ravine bottom (see Figure 1.2) and backfill from a previous construction project was to be expected. Boreholes 2 and 3 are on the nearby uplands so the fill in those locations was probably placed there as leftover soil from the earlier LY3 project.

Table 5.2 Soil types in the upper soil horizons of the Small ravine.

Borehole	Soil type	Depth below surface (m)
1	Clay fill	0.1 – 1.1
	Sand fill	1.1 – 2.4
	Silty to sandy dark grey clay	2.4 – 5.5
2	Clay fill	0.3 – 1.0
	Silty grayish brown clay	1.0 – 6.2
3	Clay fill	0.1 – 1.7
	Topsoil	1.7 – 1.8
	Silty grayish brown clay	1.8 – 6.9
4	Silty grayish brown clay	0.1 – 6.9
5	Silty dark grayish brown clay	0.1 – 5.8

Detailed soil data for the Small ravine can be found in Appendix F.

5.1.3 Geohydrology and Surface Water

5.1.3.1 Methods

Main & Small Ravine

The three test holes drilled by Thurber Engineering for soil analysis also recorded information on the groundwater, as did the five bore holes drilled by EBA Engineering Consultants in the Small ravine.

5.1.3.2 Description

Main Ravine

There are no streams or sources of running water within the Main ravine and there are no sites with standing water or any ground seeps.

Table 5.3 Groundwater levels in the Main Ravine

Test Hole	Drilled Depth (m)	Borehole Surface Elevation (m, ASL)	Groundwater Levels – Depth below surface (m)	
			At completion of Drilling	10 August, 2006
TH06-01	10.4	665.93	Dry	7.1
TH06-02	10.4	667.58	Dry	Dry
TH06-03	10.2	669.15	Dry	5.1

Standpipes were installed in each borehole and, two weeks after drilling, indicated that groundwater was present at between 5 m and 7 m below grade.

Small Ravine

There are no streams or sources of running water within the Small ravine and there are no sites with standing water or any ground seeps.

Table 5.4 Groundwater levels in the Small Ravine

Test Hole	Drilled Depth (m)	Borehole Surface Elevation (m, ASL)	Groundwater Levels - Depth below surface(m)		
			At Completion of Drilling	16 August, 2006	15 September, 2006
7100467-01	7.32	662.86	Trace	3.45	3.33
7100467-02	7.32	667.58	Dry	Dry	Dry
7100467-03	7.32	667.0	Dry	5.29	5.34
7100467-04	7.32	667.3	Dry	5.79	5.88
7100467-05	7.32	667.9	Dry	4.81	4.82

Standpipes were installed in each borehole and indicated that, six weeks after drilling, groundwater was present at between 3 m and 6 m below grade. Because the invert of the storm water pipe will be lower than this groundwater level, dewatering of the trench will be necessary.

5.1.4 Air Quality

Air quality impacts relevant to this project would relate to dust and airborne particulate matter generated by construction activities. Background data describing air quality in terms of these parameters are not typically measured in Edmonton's regional air quality programs (Clean Air Strategic Alliance 2006), therefore, no description of existing conditions could be prepared.

5.1.5 Vegetation

5.1.5.1 Methods

Vegetation resources in the NSRV are well documented. Westworth & Associates (1980) identified and mapped vegetation communities for the North Saskatchewan River Valley and Ravine System, an area which includes the Lynnwood Ravine. A reconnaissance level vegetation survey was done on 18 October 2006 to further define and map plant communities within the LY3 and LY4 ravines. Based on observations of dominant canopy species and shrub layers, plant communities within the study area were delineated on a 1:3500 air photo based map (Figure 5.1), with communities classified according to the basic classification system developed by Westworth & Associates (1980).

Given the late date of the survey, it was not possible to describe the forb or graminoid physiognomic layers, other than to note obvious species, nor was a rare plant survey possible. Plant communities were classified solely on the basis of the tree canopy and shrub layers.

5.1.5.2 Description

Regional Vegetation

The study area lies within the Central Parkland Subregion of Alberta (Natural Regions Committee 2006), which is generally characterized by mixed stands of trembling aspen and balsam poplar and rough fescue grasslands. Much of the native vegetation within this subregion has been cleared for urban and agricultural development. Remnant communities of native vegetation still exist, particularly in ravines and valley. Much of the native vegetation in Edmonton's NSRV has been protected by the River Valley ARP.

Local Vegetation

The vegetation of the study area has been altered through filling and leveling of the ravine bottom and regular mowing of the resulting grass-covered landscape. The ravine side slopes, however, have been left relatively intact. Seven main types of vegetation associations were identified in the study area (Figure 5.1).

Legend

- AP1- Aspen/Balsam Poplar 1
- AP2- Aspen/Balsam Poplar 2
- AP3- Aspen/Balsam Poplar 3
- OG1- Ornamental Garden 1
- OG2- Ornamental Garden 2
- MA- Manicured
- P1- Balsam Poplar/White Spruce
- P2- Balsam Poplar/Aspen
- W1- White Spruce/Balsam Poplar
- WM- Willow/Manitoba Maple
- Main Ravine
- Small Ravine

N

1:3,500

0 25 50 100 Meters

Figure 5-1. Lynnwood Ravine Plant Communities

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These seven associations were subdivided into eleven distinct plant communities (and classified into a modified version of the Westworth & Associates' (1980) classification system):

- Manicured
- Balsam Poplar/White Spruce
- Balsam Poplar/Aspen
- Aspen/Balsam Poplar
- White Spruce/Balsam Poplar
- Willow/Manitoba Maple
- Ornamental Garden

A complete list of plant species recorded in the Lynnwood Ravine can be found in Appendix G. Species lists for each plant community can be found in Appendix H.

MA – Manicured

The largest plant community within the ravine, it is composed of a continuous cover of mowed Kentucky Blue Grass, with scattered forbs such as Dandelion, Common Plantain and White Clover. Closer to the southeast end of the ravine, and especially near the bottom of the topographic bowl, there is an increase in the density of the forbs, particularly White Clover. This is probably due to increased soil moisture in the lowest part of the ravine.

The only other plants present in this community are several ornamental Balsam Poplar and Blue Spruce trees, at the upper (NW) end of the ravine.

Plate 5.3 MA plant community.
Looking east down ravine from 156th Street.

P1 – Balsam Poplar/White Spruce

A tall (8-9m) Balsam Poplar-dominated mixedwood with a varied, and at times dense, medium to tall shrub layer. Due to its northern aspect, there is very little ground cover in the way of forbs, graminoids or low shrubs. There is considerable deadfall within parts of this community, composed of all tree and shrub types.

Plate 5.4 Plant community P1.

P2 - Balsam Poplar/Aspen

A deciduous tree dominated community (Balsam Poplar and Trembling Aspen) with a few scattered White Spruce, Manitoba Maples, Crabapples and numerous tall (6-7m) Balsam Poplar snags. There are sites within this community where the shrub layer is quite dense due to large numbers of Aspen and Prickly Rose.

Plate 5.5 Plant community P2.

AP1 – Aspen/Balsam Poplar 1

A dense, Aspen-dominated community along a south-facing slope. The tree canopy cover (at 6-7m) is continuous, with occasional tall (8-9m) Balsam Poplar. The shrub layers are diverse and, at times, very dense.

Plate 5.6 AP1 plant community.

AP2 – Aspen/Balsam Poplar 2

A narrow band of vegetation between the ravine bottom and adjacent residential properties quite similar to AP1 except there is a much lower shrub species richness and density; the shrub layer is composed mainly of Red-osier Dogwood and Prickly Rose, with occasional tall White Spruce.

AP3 – Aspen/Balsam Poplar 3

A plant community with a continuous canopy of Balsam Polar and Trembling Aspen and with a shrub layer that is not quite as diverse or as dense as with community AP1. However, there are still some dense patches of Red-osier Dogwood and Prickly Rose scattered throughout as well as some open areas with small stands of White Spruce.

W1 – White Spruce/Balsam Poplar

This plant community is similar to the P1-Balsam Poplar/White Spruce community but the White Spruce is either co-dominant with the Balsam Poplar or forms almost pure stands. There are several tall Manitoba Maple trees and numerous standing dead Balsam Poplar and Paper Birch trees. The shrub layers are quite similar to that of the P1 community but not as diverse. In addition, there are dense stands of tall Red-osier Dogwood, Pin Cherry and Lilacs along the open edge of this community, adjacent to the manicured grass (MA) of the ravine bottom.

Plate 5.7 W1 plant community
Plant community AP3 can be seen at extreme left side of photo, just beyond the White Spruce trees.

WM – Willow/Manitoba Maple

A disturbed site in that it has been regularly mowed in which the ground cover consists of short grass with no low shrubs and only a few medium or tall shrubs. The Laurel Leaf Willows form a dense "wall" of green along a short stretch of Lynnwood Way, from ground level up to approximately 9m. The only Jackpine trees in the ravine were found at this location.

Plate 5.8 WM plant community.

OG1 – Ornamental Garden 1

A collection of about seventeen ornamental plantings of differing sizes and shapes. The vegetation in each garden varies but generally consists of one or two species of 6-7m tall trees (White Spruce, Norway Spruce, Laurel Leaf Willow), several shrubs such as Red-osier Dogwood, Potentilla, Spirea and Lilacs and a ground cover of shredded bark.

Plate 5.9 OG1 plant community.

OG2 – Ornamental Garden 2

A small ornamental garden which incorporates several American Elm trees with a few tall Big-toothed Aspen, medium Lilac shrubs and several bedding plants.

Special Status Species

No rare plants were observed during the reconnaissance vegetation survey and given the nature of the existing plant communities, the lack of any waterbodies and the absence of any unusual environmental conditions (eg., soil conditions, unique topography, uncommon microclimates) it is unlikely that any rare plants are present in the Lynnwood ravine.

5.1.6 Wildlife

5.1.6.1 Methods

Habitat Characterization

Wildlife habitat was described from the plant community mapping developed for this ESR (Section 5.1.5).

Literature Review

Existing wildlife information was compiled through a review of several publications which list wildlife species known to occur within the North Saskatchewan River valley and ravine system. A comprehensive report prepared by Westworth & Associates (1980) provided an overview of wildlife resources in the region.

Field Investigations

Three site reconnaissance trips, conducted 22 June, 6 and 18 October, 2006, evaluated habitat conditions and potential species composition in the local study area. All animal observations or signs were documented and described in terms of presence and habitat use.

5.1.6.2 Description

Based on information obtained from current provincial distribution, local records and field investigations, a total of 171 wildlife species (reptiles, birds and mammals) and 27 lepidopteron species may occur in the regional study area centered on the Lynnwood ravine (see Appendices J, K and L).

Potential Species Composition

Amphibians

Due to the lack of any waterbodies in or near the ravine, it is highly unlikely that any amphibians would be found in the study area. And though the North Saskatchewan River is not too far from the Lynnwood Ravine in terms of straight distance, the Whitemud Freeway presents a virtually insurmountable barrier for amphibian movement to or from the river.

Reptiles

There is only one species of reptile which may be present in the study area, the Red-sided Garter Snake (*Thamnophis sirtalis*). This snake is tolerant of a wide variety of habitats and may be found in forested habitats within urban areas (Russell and Bauer 2000).

Avifauna

Birds typically represent a large component of vertebrate species richness in a habitat. Avian species utilizing habitat within the study area would include migrant species (those species that travel through the region to and from breeding habitat further north), breeding species (species nesting in the area but returning south at the end of the breeding season), resident species (species that remain in the region year-round) and winter species (species that may travel to the region to spend the winter if habitat conditions to the north are not suitable).

Using various references, such as the Atlas of Breeding Birds of Alberta (Semenchuk 1992) and the Birds of Alberta (Fisher and Acorn 1998), a list was produced of the birds which possibly occur in the Edmonton region (see Appendix I). There are 190 bird species within the Central Parkland Ecoregion (this ecoregion defined by Strong and Thompson 1995), an environment which includes the city of Edmonton and which is characterized by the kinds of habitats found in the Lynnwood Ravine. Of those species, 113 of them are known to breed in this ecoregion.

The following data are specific to the Lynnwood Ravine:

- number of expected breeding species: 30
- number of year-round residents: 12
- number of species expected in winter: 37
- number of species expected in summer: 55
- number of possible species using the ravine as suitable feeding or resting habitat during migration: 130

Past studies in the North Saskatchewan River Valley parkland indicated that areas with high human disturbance, which is a measure of habitat quality, had lower diversity and lower density of breeding songbird populations (Finlay and Thormin 1997 *in* Spencer Environmental 2002). This, along with a lack of natural vegetation in the ravine bottom, may explain why the number of potential breeding species in the ravine is so much lower than the number of species which migrate through the area.

During the course of two reconnaissance visits to the ravine in June and October of 2006, the following species were recorded within the ravine:

- American Crow – adult and juvenile was recorded.
- House Wren
- Black-capped Chickadee – adult and juveniles were recorded.
- Dark-eyed Junco
- Black-billed Magpie
- House Sparrow
- Chipping Sparrow
- Red-breasted Nuthatch
- White-breasted Nuthatch
- American Robin
- Hairy Woodpecker
- Downy Woodpecker
- Ring-bill Gull
- Golden-crowned Kinglet

The presence of rectangular-shaped tree cavities in a large Balsam Poplar tree suggests that the ravine is used by Pileated Woodpeckers.

Mammals

There are 40 mammal species which are known to occur within the Edmonton region, based on species distribution and habitat requirements, and which may also occur within the Lynnwood Ravine (Appendix J). The mammal species most likely to occur are urban-adapted, disturbance-tolerant species. Small-sized mammals, such as bats, mice and voles are likely more common since they generally require much smaller home ranges or can utilize edge habitats. Several bat species, including the Little Brown and Big Brown Bats, may roost in tree cavities in mature forested stands in the ravine. Those species are commonly found near waterbodies, where they forage on insects (Pattie and Fisher 1999). The Southern Red-backed Vole, Deer Mouse and Masked Shrew are common small mammal species within Edmonton's river valley and ravines (Smith 1993, Westworth & Associates 1980) and would be expected to utilize both the grassland and forest habitats within the regional study area.

Medium-sized mammals, such as skunks, weasels, hares, coyotes and foxes, are more mobile and adapt well to areas of human development. That allows them to access more suitable habitat patches across a partially-developed matrix.

Lepidoptera

Butterfly collecting and butterfly watching are becoming an increasingly popular pastime throughout North America. Of the 82 species of butterflies which are known to occur within the city of Edmonton, 27 (33%) of them will potentially be found within the Lynnwood ravine (according to distribution and habitat information provided in Acorn (1993) and Bird et al. (1995). These species and their preferred habitats within the ravine are listed in Appendix K.

Special Status Species

The following list of special status species potentially occurring in the regional study area has been compiled to meet federal (*Species at Risk Act*) and provincial (Alberta *Wildlife Act*) requirements. This list incorporates information from the 2006 COSEWIC list, the 2000 General Status of Alberta Wild Species and List of Species under the Alberta Wildlife Act (of 14 February, 2006).

Although the study area provides suitable habitat for a variety of species, disturbance in the form of urbanization and fragmentation surrounds it. As such, while there is potential for a variety of special status species to occur, their presence is unlikely.

Table 5.5 Potential rare species in the study area.

Common Name	Scientific Name	Faunal Group*	Provincial Status	Wildlife Act Designation	COSEWIC Designation
Western Toad	*Bufo boreas*	A	Sensitive		Special Concern
Canadian Toad	*Bufo hemiophrys*	A	May Be at Risk		
Northern Leopard Frog	*Rana pipiens*	A	At Risk	Threatened	Special Concern
Wandering Garter Snake	*Thamnophis elegans*	R	Sensitive		
Plains Garter Snake	*Thamnophis radix*	R	Sensitive		
Red-sided Garter Snake	*Thamnophis sirtalis*	R	Sensitive		
Osprey	*Pandion haliaetus*	B	Sensitive		
Bald Eagle	*Haliaetus leucocephalus*	B	Sensitive		
Northern Goshawk	*Accipiter gentilis*	B	Sensitive		
Broad-winged Hawk	*Buteo platypterus*	B	Sensitive		
Swainson's Hawk	*Buteo swainsoni*	B	Sensitive		

Common Name	Scientific Name	Faunal Group*	Provincial Status	Wildlife Act Designation	COSEWIC Designation
Ferruginous Hawk	*Buteo regalis*	B	At Risk	Threatened	Special Concern
Golden Eagle	*Aquila chrysaetos*	B	Sensitive		
Peregrine Falcon	*Falco pergrinus anatum*	B	At Risk	Threatened	Threatened
Prairie Falcon	*Falco mexicanus*	B	Sensitive	Special Concern	
Sharp-tailed grouse	*Tympanuchus phasianellus*	B	Sensitive		
Upland Sandpiper	*Bartramia longicauda*	B	Sensitive		
Long-billed Curlew	*Numenius americanus*	B	May Be at Risk	Special Concern	Special Concern
Northern Pygmy-Owl	*Glaucidium gnoma*	B	Sensitive		
Burrowing Owl	*Athene cunicularia*	B	At Risk	Threatened	Endangered
Barred Owl	*Strix varia*	B	Sensitive	Special Concern	
Great Grey Owl	*Strix nebulosa*	B	Sensitive		
Short-eared Owl	*Asio flammeus*	B	May Be at Risk		Special Concern
Common Nighthawk	*Chordeiles minor*	B	Sensitive		LP Candidate
Black-backed Woodpecker	*Picoides arcticus*	B	Sensitive		
Pileated Woodpecker	*Dryocopus pileatus*	B	Sensitive		
Great-crested Flycatcher	*Myiarchus crinitus*	B	Sensitive		
Purple Martin	*Progne subis*	B	Sensitive		
Barn Swallow	*Hirundo rustica*	B	Secure		HP Candidate
Sedge Wren	*Cistothorus platensis*	B	Sensitive		
Sage Thrasher	*Oreoscoptes montanus*	B	Undetermined		Endangered
Sprague's Pipit	*Anthus spragueii*	B	Sensitive	Special Concern	Threatened
Loggerhead Shrike	*Lanius ludovicainus exubitorides*	B	Sensitive	Special Concern	Threatened

Common Name	Scientific Name	Faunal Group*	Provincial Status	Wildlife Act Designation	COSEWIC Designation
Cape May Warbler	*Dendroica tigrina*	B	Sensitive		
Black-Throated Green Warbler	*Dendroica virens*	B	Sensitive	Special Concern	
Blackburnian Warbler	*Dendroica fusca*	B	Sensitive		
Bay-breasted Warbler	*Dendroica castanea*	B	Sensitive		
Blackpoll Warbler	*Dendroica striata*	B	Secure		LP Candidate
Canada Warbler	*Wilsonia canadensis*	B	Sensitive		
Western Tanager	*Piranga ludoviciana*	B	Sensitive		
Brewer's Sparrow	*Spizella breweri*	B	Sensitive		IP Candidate
Lark Bunting	*Calamospiza melanocorys*	B	Sensitive		
Grasshopper Sparrow	*Ammodramus savannarum*	B	Sensitive		
McCown's Longspur	*Calcarius mccownii*	B	Secure		Special Concern
Bobolink	*Dolichonyx oryzivorus*	B	Sensitive		
Rusty Blackbird	*Euphagus carolinus*	B	Secure		Special Concern
Western Small-footed Bat	*Myotis ciliolabrum*	M	Sensitive		
Fisher	*Martes pennanti*	M	Sensitive		
Long-tailed Weasel	*Mustela frenata*	M	May Be at Risk		
American Badger	*Taxidea taxus taxus*	M	Sensitive		
Mountain Lion/Cougar	*Felis concolor*	M	Sensitive		
Canada Lynx	*Lynx canadensis*	M	Sensitive		
Bobcat	*Lynx rufus*	M	Sensitive		

* Faunal groups are: A = amphibians; R = reptiles; B = birds; M = mammals.

Purple martins are an urban-adapted species that nest in semi-open forests near water (Fisher and Acorn 1998). Competition from invasive species (e.g., European starlings) and expansion of human settlement have had adverse effects on their nesting sites (Alberta Sustainable Resource Development 2000).

Wildlife Movement Corridors

Wildlife corridors link larger habitat areas, accommodating daily, seasonal or dispersal movements that enable genetic exchange and access to other resources (Paquet *et al.* 2004), thus, they play a key role in dispersal of wildlife populations. The viability of an area as a wildlife corridor is a function of the continuity in its vegetation structure, width, amount and type of surrounding disturbance and the quality of habitat it connects. Major wildlife corridors provide cover and resources, connecting large habitat areas at a regional scale. They can support a high diversity of species. Minor wildlife corridors provide only limited cover and resources, lack the continuity in vegetative structure found in major wildlife corridors and support a smaller suite of wildlife species. Open spaces with little vegetative structure, including highly-developed agricultural and urban areas, are much less permeable to wildlife movement and dispersal, since many species will not cross areas that lack vegetative cover (gaps).

The Lynnwood Ravine would serve as a movement corridor for wildlife but only for a very short distance (600m maximum) and only within the immediate area. The ravine is bordered on the north, west and east sides by residential areas and on the east end by the Whitemud Freeway.

Birds, particularly passerines, would use the ravine as a movement corridor and then would have to fly over the freeway to another narrow band of forested habitat which runs along the south side of the freeway down to the North Saskatchewan River (which is approximately 1.8 km to the southeast). Small mammals would find reasonably good habitat within the ravine but would not be able to use the ravine as a travel corridor to other, similar habitats because of the difficulties involved with crossing the six lane freeway (and associated tall cement median).

Medium sized mammals, such as Coyotes or Red Foxes would be uncommon in the ravine because it is too small to sustain animals with their range requirements and because it is not physically linked to suitable corridor habitat, i.e. the North Saskatchewan River.

5.2 Socio-Environmental Resources

5.2.1 Land Disposition and Zoning

5.2.1.1 Methods

Land disposition and zoning will not change as a result of the project. A land title search done on 12 February 2007, indicated that the Lynnwood Ravine comprises two parcels of land (Plan 4615KS, Lot E and Plan 4615KS, Lot F) both of which are owned by the City of Edmonton.

5.2.1.2 Description

The Lynnwood Ravine (including both the Main and Small ravine sections) is zoned as Metropolitan Recreation Zone (Zones A and AP) (See Figure 5.2). The residential areas bordering the sides of the ravine are zoned as RF1 (Single Detached Residential Zone) while the

Lynnwood Community League and adjacent field is zoned as AP (Public Parks Zone) and the Lynnwood Elementary School as US (Urban Service Zone).

5.2.2 Utilities

Existing utilities in the study area were identified by the preliminary design reports produced by Earth Tech and Sameng. Utility conflicts will be addressed in the detailed design and flagged prior to construction but from the information available to date, there are no utilities which will need to be removed or re-alligned.

5.2.3 Land Use

5.2.3.1 Methods

Recreational land use within the Lynnwood Ravine area was determined by observations during site reconnaissance visits and thorough discussions with neighbourhood residents during the public open house.

5.2.3.2 Description

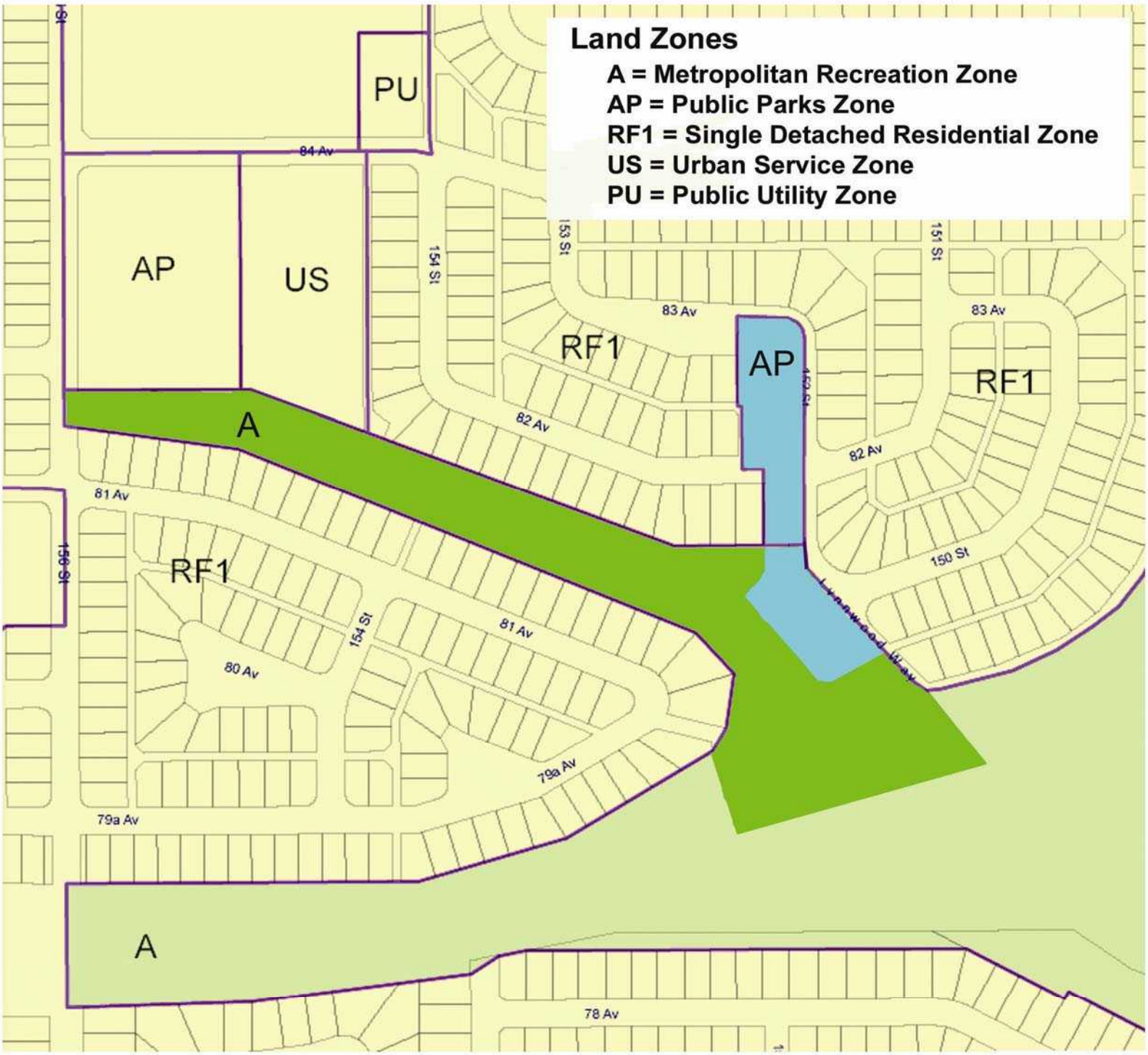
The Lynnwood Ravine is used by area residents as a recreational area, mainly for short hikes and as a dog walking site. The steep-sided bowl at the south-east end of the ravine is used as a winter sledding hill by neighbourhood children. Some residents also use the ravine for cross-country skiing. No formal trails exist within the ravine. Access to the ravine is from either the western end at 156th Street, the southeastern end at Lynnwood Way or via two gravel trails at the midpoint of the ravine, one from each of the north and south sides. The ravine has no links with trails within the North Saskatchewan River Valley due to the positioning of the Whitemud Freeway at the ravine's terminus.

5.2.4 Worker and Public Safety

This section does not constitute a detailed prescription of safety measures that should be employed during construction activities as that was considered beyond the scope of this ESR. Our assumption is that the construction project would conform to all applicable municipal, provincial or federal worker and public safety regulations or protocols.

5.2.4.1 Methods

Our analysis of worker and public safety concerns was restricted to identification and consideration of conditions particular to this project that might pose risks to worker and public safety, particularly those linked to identified environmental impacts or local resources. This was done by considering all of the information presented in the preceding chapters of this document to identify physical locations or activities unique to this project that might result in concerns.



Legend

Lynnwood Ravine

- Main Ravine
- Small Ravine

Figure 5-2. Land Zoning in the Lynnwood Ravine Regional Location

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5.2.4.2 Description

For the proposed project, worker and public safety concerns are most likely to arise during work immediately adjacent to several large trees in the ravine bottom. The following elements were identified as having potential to result in worker or public safety concerns:

- Potential for worker safety while trenching next to large trees.
- Potential for worker safety while working along 82nd Avenue and/or Lynnwood Way.
- Potential for construction activities to pose a hazard to public safety.
- Potential for wildfires during construction and operation in proximity to natural fuel loads.

The potential for the above scenarios to occur is examined in Chapter 6.

5.2.5 Visual Resources

5.2.5.1 Methods

Visual resources were assessed during the site reconnaissance trips on 22 June and 6 and 18 October, 2006. Photographs of both the Main and Small ravines and the surrounding residential areas area were taken from various vantage points both inside and outside of the ravines.

5.2.5.2 Description

Because the bottom of the Main ravine has no shrubs, few trees and is maintained as manicured short-grass cover, persons walking in the ravine have unobstructed views down relatively long sections of the ravine.

There are only two places from which people outside of the ravine can see into the ravine:

- From the sidewalk along the east side of 156th Street. Views down the length of the ravine would be partially obstructed by the planted ornamental trees at the western end of the Main ravine.
- From the edge of the ravine at its southeastern terminus, on the grass boulevard adjacent to Lynnwood Way. A person standing at this point can see down into the ravine whereas people walking along the sidewalk adjacent to the closest residences are not able to see below the edge of the ravine slope.

5.2.6 Heritage Resources

5.2.6.1 Methods

An historical resource assessment was not completed for the Lynnwood Ravine due to the substrate conditions identified by the geotechnical surveys.

5.2.6.2 Description

The geotechnical surveys done for both the Main and Small ravines indicated that between 1.8 m and 2.5 m of disturbed soil has been added to the surface of the ravine bottom. This fill was likely laid down when the original Lynnwood trunk line was laid in the ravine in the 1960's and the fill contains non-soil material such as junk metal and bits of broken glass. As such, it is

highly unlikely that there are any resources of historical significance in the areas to be disturbed by either the LY3 or LY4 projects.

6.0 IMPACT AND MITIGATION MEASURES

Interactions of specific project activities in the site preparation, construction and operation/maintenance phases of the project with VECs are summarized in Table 6.1. Following this table is a description of the interactions which have the potential to result in an environmental impact.

6.1 Environmental Resources

6.1.1 Geomorphology/Terrain

Potential impacts related to soils from the proposed project are restricted to potential slope destabilization due to ponding water.

6.1.1.1 Potential slope destabilization due to water collection in the ravine.

Impact

According to eyewitness reports from residents living adjacent to the Lynnwood Ravine, standing water in the lower reaches of the ravine reached depths of at least 1.5 – 2.0 m (and possibly higher) once the severe rain storm of 11 July, 2004, had ended. This water took a very long time to drain completely from the ravine, probably due to both the volume of water and the mass of hail which accumulated around the stormwater outlet drain, preventing the free flow of water into the drain pipe. The eyewitness accounts estimated that standing water was still present in the ravine almost 24 hours after the storm event. The ravine side slopes in the areas covered by the ponding water are steep and, because they occur under the White Spruce/Balsam Poplar plant community, do not have continuous or dense plant cover. As such, it is possible that the presence of water on these slopes could lead to increased soil infiltration, weakening the stability of the slope and resulting in increased slope erosion and possibly, slope failure. The impact of this ponded water on slope stability is considered adverse, major, long-term and predictable.

Table 6.1 VEC analysis matrix

			Project Activities										
			Site Preparation				Construction						Monitoring
			Establish staging areas	Vegetation clearing	Install silt fences and hoarding	Coordinate access and public safety requirements	Trenching for LY3	Installation of inlet,/overflow structure	Digging shafts for LY4,& LY2A	Tunnelling for LY4 & LY2A	Landscaping and contouring of LY12,LY3 & LY4	Reclamation of disturbed all areas	Reclamation monitoring
Valued Ecosystem Components	**Valued Ecosystem Components**	**Geomorphology**	√	√		√	√	√	√	√	√	√	√
		Soils	√	√			√	√	√		√	√	√
		Hydrology/Surface Water					√		√		√	√	
		Vegetation	√	√			√	√	√		√	√	√
		Wildlife	√	√			√	√	√		√	√	√
	Valued Social Components	**Land Disposition and Zoning**											
		Recreational Land Use	√	√	√	√	√	√	√		√	√	√
		Worker and Public Safety	√	√		√	√	√	√	√	√	√	
		Visual Resources	√	√	√		√	√	√		√	√	√
	Valued Heritage Components	**Heritage Resources**		√			√	√	√	√			

Mitigation Measures and Residual Impact

By adding an additional outlet structure at the end of the Main ravine, water will be moved out of the ravine more quickly. This will decrease the time during which water can pond in the ravine and consequently, decrease the amount of water infiltrating into the topsoil along the ravine side slopes. A computer model simulation based on a 1:100 year 4 hour storm event indicated that the existing 200 mm open pipe outlet structure would require 20 hours to empty the ravine. Installation of a 1200 mm outlet structure would reduce this water ponding time to just under 3 hours (see Figure 2.4). As a result, the residual impact would be positive, minor, long-term and predictable.

Potential impacts, mitigation measures and residual impacts are summarized in Table 6.2.

Table 6.2 Review of impacts analysis for geomorphology

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Affect on slope stability from stormwater ponding	Adverse, major, long-term, predictable	Ensure that stored floodwaters in the ravine are able to move out quickly	Positive, minor, long-term, predictable

6.1.2 Soils

Potential impacts related to soils from the proposed project include:

- Topsoil loss due to erosion
- Topsoil compaction
- Degradation of topsoil through mixing with subsoil
- Disposal of possibly contaminated soils
- Hazardous material spills

6.1.2.1 Topsoil loss due to erosion

Impact

In areas where existing vegetative cover is cleared, exposed soils will be susceptible to erosion. Soils on slopes are particularly susceptible to erosion as a result of surface runoff. The Main ravine slope is very shallow. A reverse grade to the inlet/overflow structure along with surface grading downstream of the structure will ensure that ponding on the ravine floor will be minimized.

The Small ravine slopes are also very shallow, except where they join the Main ravine. If the reception shaft for the LY4 project (which needs to be placed in the bottom of the Main ravine) is not located on the steep side slopes, then soil erosion will not be a significant concern for the LY4 project.

Best environmental construction practices as stated in the City of Edmonton's "Erosion and Sedimentation Control Guidelines" (City of Edmonton 2005) will be followed in any areas to be disturbed by construction, including the use of temporary and permanent erosion protection measures (e.g., silt fencing) on any slope susceptible to erosion. Planned measures to be used during construction activities are illustrated in Figure 6.1. Based on those measures, the impact of soil erosion will be adverse, minor, temporary and predictable.

Mitigation Measures and Residual Impact

All excavation or regrading activities near the ravine slopes must be undertaken in a manner to minimize any potential adverse impacts on slope stability. The contractor will prepare an Erosion and Sedimentation Control Plan for this project which will be implemented prior to the work commencing. Temporary erosion control measures will remain in place until vegetation becomes re-established in the disturbed areas and will be inspected regularly during the construction phase. Re-vegetation efforts will begin as soon as possible after construction is complete. Monitoring both the erosion control measures and progress of re-vegetation will further minimize impacts. Stockpiled top soil and fill will be covered so as to avoid soil erosion and slopewash in the event of severe rainstorms during construction activities. Given those measures, the potential for loss of soils within the working areas will be negligible over the short and long-terms.

6.1.2.2 Topsoil compaction

Impact

Compaction could occur on topsoils where heavy equipment will be operating and after grading and replacement of soils during reclamation. Compacted soils limit root penetration, thereby reducing the ability of vegetation to become established in reclaimed areas. The potential impact would be a slower rate of plant regeneration or a reduced capability for effective reclamation. Soil compaction is rated as an adverse, minor to major, long-term, predictable impact.

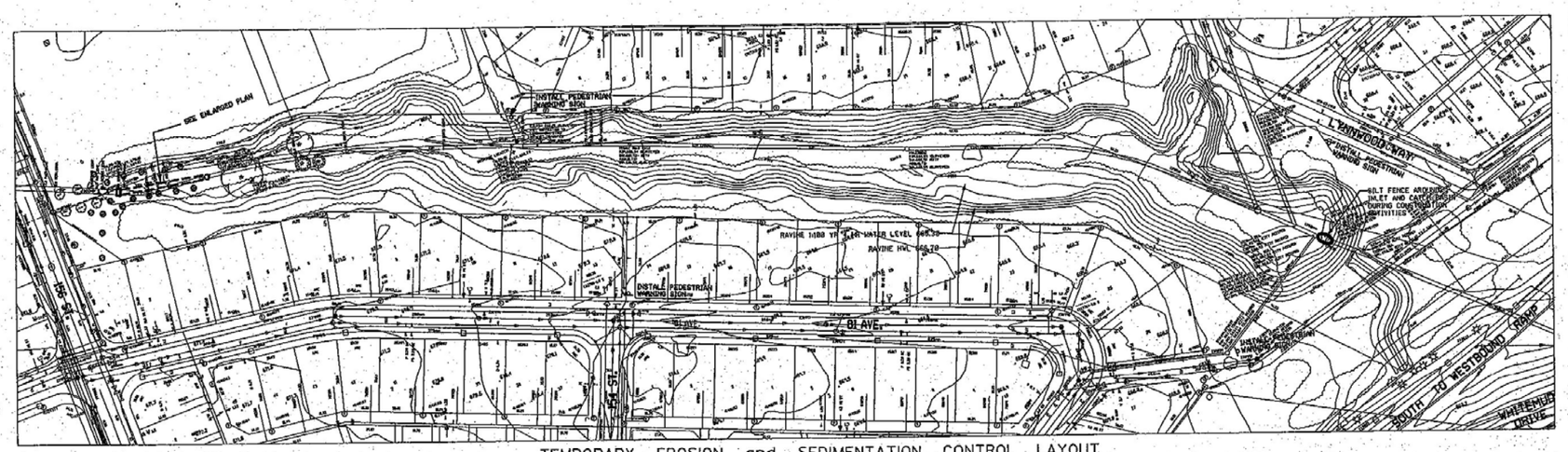
Mitigation Measures and Residual Impact

The following steps will prevent soil compaction in areas to be reclaimed:

- Minimize construction traffic especially when soils are wet.
- Avoid formation of ruts.
- Prior to topsoil replacement, rip finer subsoils to alleviate compaction (coarse-textured subsoil will likely not require ripping).
- Contour subsoils to match the natural landscape as closely as possible, within the constraints placed by having to slope the Main ravine bottom to an acceptable hydraulic gradient.
- Replace topsoil evenly.

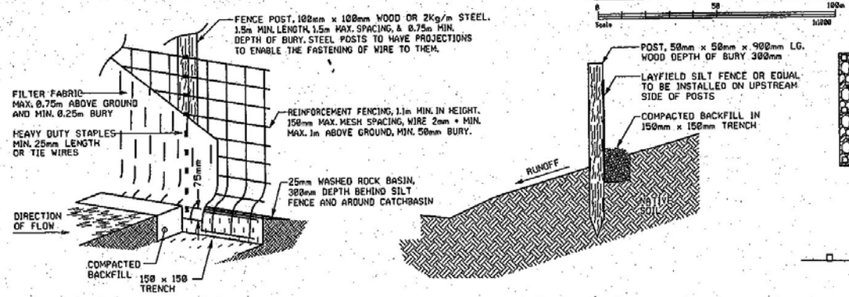
In areas where the ground surface will be completely landscaped (e.g., the Main ravine, the steep slopes around the Small ravine working shafts), the contractor will ensure geotechnical stability

is maintained and they will provide site specific erosion controls that are consistent with overall drainage patterns. With those measures, the residual impact will be negligible.



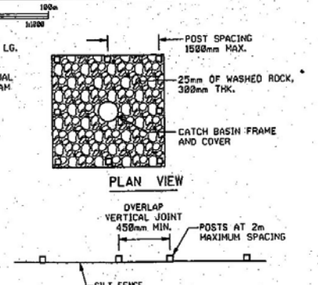
TEMPORARY EROSION and SEDIMENTATION CONTROL LAYOUT

Scale 0 50 100m 1:2000



REINFORCED SILT FENCE AROUND CATCH BASINS

LONGITUDINAL SILT FENCE
(ALONG ROADWAYS AND AROUND STOCKPILES)



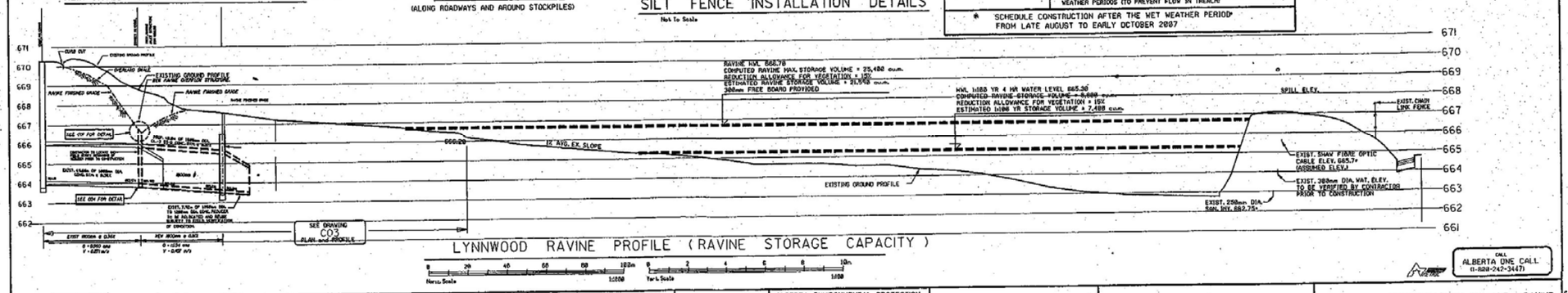
SILT FENCE INSTALLATION DETAILS

Not to Scale

EROSION and SEDIMENTATION MITIGATION MEASURES (BMP'S) DURING CONSTRUCTION (CONTRACTOR TO USE AS A GUIDE ONLY AND UTILIZE OTHER MITIGATION MEASURES THAT MAY BE MORE EFFECTIVE)	
ACTIVITY OR CONDITION	BEST MANAGEMENT PRACTICE (BMP)
STRIPPING	- AVOID WET WEATHER PERIODS. - PROMOTE JUST IN TIME STRIPPING (MINIMIZE EXPOSED SOILS) - INSTALL SILT FENCES BELOW DISTURBED AREAS AND AROUND STOCKPILES
SITE ACCESS	- IF MUD TRACKING OFFSITE IS OCCURING, INSTALL TEMPORARY WASH ROCK ENTRANCES (MINIMUM 15m IN LENGTH) UTILIZING 50mm ROCK. ALTERNATIVE METHODS MAY BE SUITABLE.
EXCAVATION	- AVOID WET WEATHER PERIODS. - INSTALL SILT FENCES BELOW DISTURBED AREAS AND AROUND STOCKPILES
EXPOSED SOIL	- SURFACE ROUGHEN/TEXTURE. - TOPSOIL AND SEED/SOD/HYDROSEED EARLY.
STORM PIPE REMOVAL AND REPLACEMENT	- AVOID WET WEATHER PERIODS. - MONITOR UPSTREAM WEATHER. - ENSURE GAPS BETWEEN NEW PIPE AND EXISTING PIPE TO BE REMOVED ARE TEMPORARY JOINED DURING CONSTRUCTION STOPAGES AND WET WEATHER PERIODS (TO PREVENT FLOW IN TRENCH
* SCHEDULE CONSTRUCTION AFTER THE WET WEATHER PERIOD FROM LATE AUGUST TO EARLY OCTOBER 2007	

NOTES:

1. CONTRACTOR TO COMPLY WITH THE REQUIREMENTS OF THE CITY OF EDMONTON'S "EROSION AND SEDIMENTATION CONTROL GUIDELINES".
2. CONTRACTOR TO BE RESPONSIBLE FOR INSTALLING, MONITORING/REPORTING AND MAINTAINING ALL TEMPORARY AND PERMANENT EROSION CONTROL MEASURES UNTIL THE FINAL ACCEPTANCE CERTIFICATE HAS BEEN ISSUED.
3. TEMPORARY EROSION AND SEDIMENTATION CONTROL MEASURES TO BE INSPECTED ONCE PER WEEK AND AFTER HEAVY RAIN STORMS, FORWARD INSPECTION REPORT TO ENGINEER FOR REVIEW.
4. CONTRACTOR IS RESPONSIBLE TO ADJUST TEMPORARY EROSION AND SEDIMENTATION CONTROL MEASURES DURING AND AFTER CONSTRUCTION IF IT IS DETERMINED MEASURES ARE NOT PERFORMING EFFECTIVELY.



LYNNWOOD RAVINE PROFILE (RAVINE STORAGE CAPACITY)

Horiz. Scale 0 20 40 60 80 100m 1:1000; Vert. Scale 0 2 4 6 8 10m 1:100

CALL ALBERTA ONE CALL (1-828-242-3447)

UTILITIES SEARCH RECORD					
	DATE CHK	DATE CHK		DATE CHK	DATE CHK
DRAINAGE	Mar.13, 2007		ENGINEERING		
CATCH BASINS			CABLE T.V.		
WATER			MONUMENTS		
GAS (N.U.L.)	COMPUTER		A.G.T.	COMPUTER	
EDM. POWER			PIPELINES		
TRAFFIC LTS.					
EDM. TEL.					
CHECKED BY: Eddy					
X-ING PERMIT	DATE:		NO.		

REVISIONS			
NO.	DATE	DESCRIPTION	APPROVED BY
			NO LETTER OF
			Feb 6, 2006

SCALES: HOR. AS NOTED VERT. AS NOTED
DRAWN BY: Eddy DATE: Mar.13, 2007
CHECKED BY: DATE:
ISSUED BY: DATE:
AUTHORIZATION
SIGNED BY: DATE
PROJECT MANAGER DATE
PROGRAM MANAGER DATE
DIRECTOR OF DRAINAGE DATE

ENGINEERS STAMP

ALBERTA ENVIRONMENTAL PROTECTION
PERMIT TO CONSTRUCT
NO AUTHORIZATION REQUIRED
DATE FEB 6-2006
CONSTRUCTION RECORD
FOREMAN
FOREMAN
STARTED
INSPECTION
FIELD BOOK
PERMIT TO PRACTICE

The City of Edmonton
ASSET MANAGEMENT AND PUBLIC WORKS
DRAINAGE SERVICES

PROJECT NO.: LYNNWOOD LY12 AND LY3 - RAVINE
DESCRIPTION: INLET / OUTLET CONTROLS PROJECT
LOCATION: 156th STREET to WHITEMUD DRIVE and 81st AVENUE to 82nd AVENUE
EROSION and SEDIMENTATION CONTROL PLAN and RAVINE STORAGE CAPACITY PLAN

ORDER No.	DRAWING NO.	SHEET	FILE NO.
ACCT.	9 OF 9	C09	

Figure 6.1 Erosion and Sedimentation Control Layout, and Lynnwood Ravine Profile

6.1.2.3 Degradation of topsoil through mixing with subsoil

Impact

Topsoil conservation is an important aspect of any work requiring clearing or earthworks. Loss or degradation of topsoil through mixing with sub-soils can result in reduced soil fertility and reclamation capability. However, the LY3 project and the lower reaches of the LY4 project occur in areas in which the top 2.0 m of the topsoil are actually fill placed in the ravines from an unknown source at least two decades previously. As such, there is no danger of degrading the existing soil profile through the mixing of topsoil and lower horizon soils. Using clean fill in the reclamation process will permit the contractor to create a more natural soil profile by filling any excavations with a lower layer of clay (similar to what is found at depth in several of the boreholes) topped with a layer of black soil. Mixing of the topsoil with the subsoil is rated as a negligible impact.

Mitigation Measures and Residual Impact

Replacing soil layers as indicated above, under the guidance of a qualified soil scientist, and using the soils for reclamation efforts within the area after construction completion will ensure the impact remains negligible.

6.1.2.4 Disposal of possibly contaminated soils

Impact

Reports of foreign objects being encountered during the geotechnical surveys indicates some possibility that the fill soil may contain some contaminated material. Further, the origin of the fill soil is not known. That soil, if it was contaminated, could not be re-used for backfilling and re-contouring once the storm water pipes and associated structures were in place. The potential for contaminated soils to exist would be an adverse, major, long-term and predictable impact.

Mitigation Measures and Residual Impact

The contractor will ensure that all excavated soils taken from the zone of previous fill are stored in a manner that will prevent sediment loss onto the ravine surface in the event of rain storms. In the event that modern garbage is encountered during construction, construction activity will cease and soils from that area will be tested for the presence of contaminants. Depending on the results of testing, those soils will be appropriately disposed of according to best management practices for contaminated soils. Following those procedures, the impact would then be negligible.

6.1.2.5 Hazardous materials spills

Impact

Fuels or lubricants spilled over soils at the staging areas during equipment maintenance or refueling, when stored on-site or in the event of an accident on-site (e.g., leaking hydraulic hoses) can cause localized soil contamination. If spills are large, there is potential for the material to spread over a larger area, placing the soils in surrounding areas at risk and raising the

possibility of contamination down-slope in the ravine. Fuels and other hazardous chemicals will be stored in a protected location with secondary containment to reduce spill potential. Refueling of motorized equipment and vehicles will occur away from ravine slopes, and curbside catch basins will be hoarded appropriately to avoid hazardous material entering the stormwater system. Equipment may be serviced by mobile refueling equipment, provided they adhere to the distance restriction described above.

Only minor equipment repairs will be completed in the field; major repairs will take place at a central location such as the staging areas, or off-site. Accidental spills from equipment working on-site will be handled by following provincial best-management practices and codes of practice. If standard operating practices are followed, little potential exists for large spills; however, should one occur, the spill will be contained and disposed of following provincial guidelines. Potential for hazardous materials spills is, therefore, negligible.

Mitigation Measures and Residual Impact

No mitigation measure other than standard operating procedures and provincial hazardous materials spill regulations are needed. Spill kits will be carried on equipment or stored at nearby work locations and all personnel will be trained to respond appropriately to a spill. A spill protection plan will be in place to ensure any spills are quickly and effectively cleaned up. Such measures will reduce the ability for a spill to spread and increase the efficiency of a clean-up. The residual impact remains negligible.

Potential impacts, mitigation measures and residual impacts are summarized in Table 6.3.

Table 6.3 Review of impacts analysis for soils

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Topsoil loss due to erosion	Adverse, minor, temporary, predictable	• Contractor to prepare an Erosion and Sedimentation Control Plan which will be implemented prior to the work commencing. • Cover stockpiled soil. • Maintain erosion control measures in place until vegetation has become re-established • Temporary erosion control measures will remain in place until vegetation becomes re-established in the disturbed areas and will be inspected regularly	Negligible

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
		during the construction phase. • Begin revegetation efforts as soon as possible following completion of construction, using sod to re-vegetate all disturbed areas • Monitor the progress of re-vegetation in disturbed areas	
Topsoil compaction	Adverse, minor to major, long-term, predictable	• Grade slopes as closely as possible to match existing side slopes. • Ensure slope stability and site specific erosion control for steep slopes resulting from construction • Disk topsoil following replacement	Negligible
Degradation of topsoil through mixing with subsoil	Negligible	• None other than standard construction measures: • Utilize clean fill and black topsoil for site reclamation	Negligible
Disposal of possibly contaminated soils	adverse, major, long-term, predictable.	• Test soils for toxic substances (solids and chemicals) if modern garbage is encountered • If testing identifies contaminated soils, dispose of soils in appropriate manner • Replace soils with clean fill	Negligible
Hazardous material spills	Negligible	• Follow standard construction measures and provincial hazardous materials spill regulations • Refuel equipment away from ravine slopes • Ensure hazardous chemicals are stored in	Negligible

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
		appropriate containers • Ensure spill kits are accessible • Ensure all personnel are trained in the use of spill kits and immediate response • Ensure spill protection plan is in place	

6.1.3 Geohydrology and Surface Water

Because there is no permanent surface water located within the Lynnwood Ravine, there will be no impacts of the improvement projects on any waterbodies. Most of the potential impacts related to the temporary presence of surface water in the ravine have been dealt with in Sections 6.1.1 (Geomorphology/Terrain) and 6.1.2 (Soils). Potential impacts related to presence of surface water from the proposed project are restricted to the effects of standing (i.e. ponded) water.

6.1.3.1 Storm water ponding

Impact

The presence of high levels of standing water in the Lynnwood Ravine for up to 24 hours following a severe storm event increases the likelihood of basement flooding for those homes adjacent to the ravine. This ponded water would also delay the drainage of flood waters out of the yards of those homes, increasing the likelihood of water damage to the yards. The presence of storm water on the ground surface of the ravine for long time periods would have adverse, minor to major, temporary and predictable impacts.

Mitigation Measures and Residual Impact

The installation of an additional, and larger, outlet pipe in the southeast end of the Main Ravine will ensure that floodwaters on the surface are moved quickly out of the ravine. Flooding of homes near the Lynnwood Ravine due to ponded surface water in the ravine will be unlikely with the provision of 1.90 m freeboard from the high water level and the installation of a larger outlet opening to drain the stored floodwaters. The residual impact will be positive, major, long-term and predictable.

Potential impacts, mitigation measures and residual impacts are summarized in Table 6.4.

Table 6.4 Review of impacts analysis for surface water

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Residence flooding from stormwater ponding	Adverse, minor to major, temporary, predictable	• Installation of a larger outlet pipe opening to lower the ponded water level faster	Positive, major, long-term, predictable.

6.1.4 Air Quality

Potential impacts related to air quality from the proposed project are restricted to creation of construction dust.

6.1.4.1 Construction dust

Impact

Excavation, landscaping and topsoiling activities have the potential to generate dust but the volume of dust is dependent on several factors including weather, the intensity of the construction activities and their timing. In dry conditions, construction vehicle movement within the ravines could also generate dust. In extremely dry conditions, the construction and landscaping may introduce dust into the adjacent residential areas, potentially affecting homeowners and/or residents using other parts of the ravines for recreation. The presence of dust in the study area, if not controlled, would be an adverse, minor, predictable impact that will last for the duration of construction.

Mitigation Measures and Residual Impact

While the health risk to motorists, homeowners and ravine users from construction dust would be minor (and in most instances the dust would be considered only a nuisance), the risk is slightly higher for users with respiratory sensitivities, particularly during periods of high dust release. Warning sings will be placed in the project area while dust-creating activities are occurring as a preventative measure. Although the dust generating activities will occur very close to some homes, the spatial extent of the affected ravine and road surfaces are relatively small and could easily be wetted down during very dry periods. These measures will help reduce the risk for all motorists and trail users, and the residual impacts of dust release would be reduced to a negligible level.

Potential impacts, mitigation measures and residual impacts are summarized in Table 6.5.

Table 6.5 Review of impacts analysis for air quality

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Generation of construction dust	Adverse, minor, temporary, predictable	• Use appropriate dust control measures, particularly during construction in dry periods	Negligible

6.1.5 Vegetation

Potential impacts related to vegetation from the proposed project include:

- Loss of native vegetation
- Loss of trees
- Disturbance to manicured areas
- Introduction of weedy or invasive species
- Accidental contaminant spills

6.1.5.1 Loss of native vegetation

Impact

Clearing of vegetation will be required at two sites: along the upper (west) section of the Main ravine where open trenching will be used and at the location of one (and perhaps more) of the LY4 & LY2A working shafts. Vegetation clearing in the Main ravine will consist solely of relocating several ornamental trees (see Section 6.1.5.2). One or two sites within the Small ravine may have to be cleared of natural vegetation in order to place the vertical working shafts for the LY4 & LY2A prjects. Natural areas within the river valley ravine system are valued as important green space. The impact of loss or damage to this green space would be adverse, major, permanent and predictable.

Mitigation Measures and Residual Impact

Prior to construction, marking the clearing limits with snow-fence or highly-visible flagging so as to minimize the extent of vegetation loss. Any disturbance to native vegetation will be reclaimed by revegetating the affected areas with identical or similar species and/or by landscaping the sites and actively encouraging natural revegetation. A monitoring program will be undertaken for monitoring the rate and success of a natural revegetation program.

Reclamation plans will be included in the construction contractors' Landscape Maintenance Plan. The construction contractor will ensure that detailed designs will result in the least impact possible to native vegetation in the project area and that all impacts to native vegetation will be mitigated in final project design. The Landscape Maintenance Plan will be submitted to City of Edmonton Parks Branch for review and approval. Until detailed designs are available for the

project, the residual impact to native vegetation will remain adverse, minor (due to the already disturbed nature of the ravine bottom), short to long-term and predictable.

6.1.5.2 Loss of trees

Impact

LY3 Project

In the Main ravine, access routes and laydown areas are located at the north bank of the ravine immediately east of 156th Street. The open trenching operations will require the relocation of four small (3-4 m) spruce trees to the south side of the main ravine immediately east of 156th Street (see Figures 6.2 and 6.3).

LY4 Project

The microtunelling or hand-tunnelling methods to be used in the Small ravine will require a reception shaft be dug in the side slope of the lower Main ravine, an activity which may require the removal of numerous small Aspen and Balsam Poplar trees. Additional trees may have to be removed due to working shafts constructed along 82nd and 83rd Avenues. Healthy trees will be removed and relocated to other areas within the project area. Unhealthy trees identified by the City's forester will be removed and disposed of. All healthy trees that are damaged or trees that do not survive relocation will be replaced pursuant to the City's Corporate Tree Management Policy. However, the extent of this impact is unknown at this time because the exact site of the reception shaft has not yet been determined.

The impact to the ornamental and native trees will be adverse, minor, short-term to long-term and predictable.

Mitigation Measures and Residual Impact

All trees (ornamental and native) on city property, including the Lynnwood Ravine, fall under the City of Edmonton's Corporate Tree Management Policy. This policy requires that all trees on City property be adequately protected from unnecessary damage, destruction or loss. Pursuant to this policy, large trees in the construction area would be avoided or hoarded to protect them from damage (e.g., root damage) and all trees removed would be replaced by the construction contractor. Most of the trees which will need to be relocated are relatively small (3-4 m). The impact of having to remove them would be adverse, minor, short-term to long-term and predictable.

6.1.5.3 Disturbance to manicured areas

Impact

In addition to the impacts to natural vegetation related to clearing for construction activities as stated above, manicured grasslands in the Main and Small ravines will be disturbed by construction and landscaping activities. Manicured sites are valued green spaces and the impact of temporary disturbance and potential loss of these plant communities would be adverse, minor, temporary and predictable.

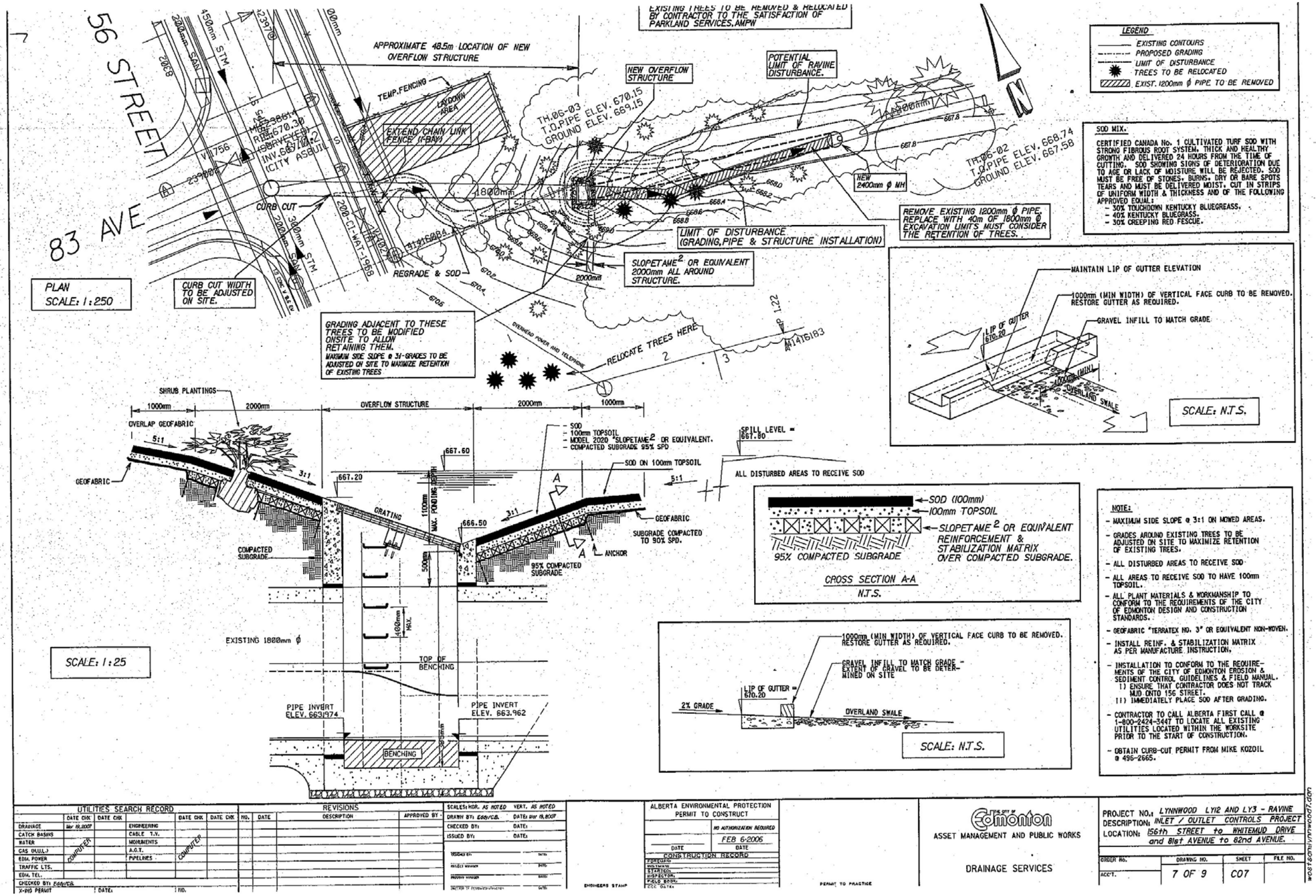


Figure 6.2 Ravine Swale and Cross-sections

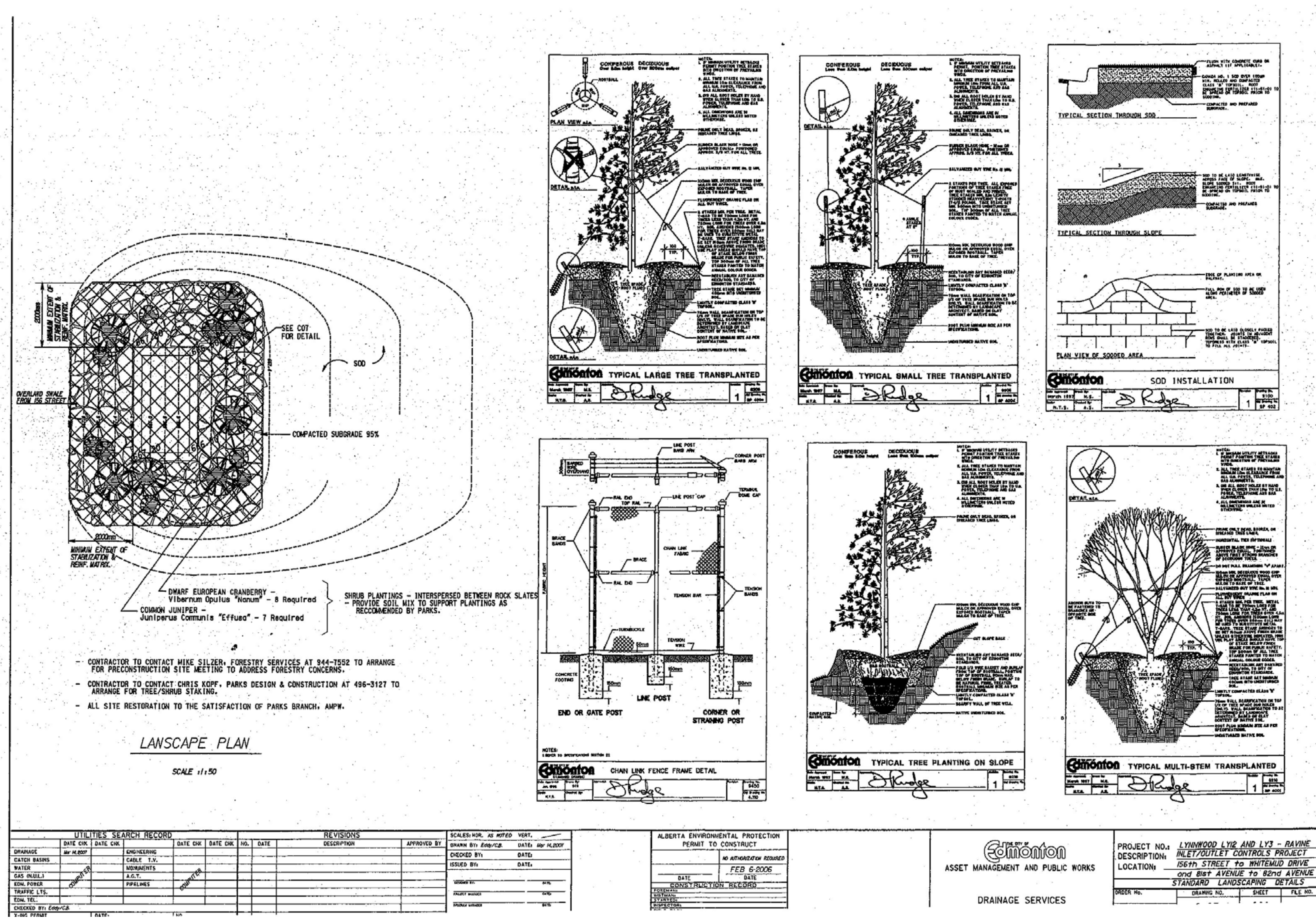


Figure 6.3 Landscape Plan

Mitigation Measures and Residual Impact

Any disturbance to manicured areas will be reclaimed by the construction contractor by revegetating the areas according to the Landscape Plan with an appropriate seed mix recommended by the City of Edmonton Parks Branch, AMPW. Revegetated areas will be monitored and maintained by the construction contractor according to their Landscape Maintenance Plan for one year. The Landscape Maintenance Plan will be submitted to City of Edmonton Parks Branch for review and approval. With these mitigative measures implemented, the residual impacts will be reduced to negligible.

6.1.5.4 Introduction of weedy or invasive species

Impact

Clearing activities increase the opportunity for disturbance-adapted, weedy and invasive species to become established. Equipment can transfer weeds through seeds deposited on the equipment while clearing vegetation elsewhere in the region. Facilitating establishment of weedy species is undesirable as it will create an on-going maintenance issue and reduce the value of the habitat. Because the disturbed sites are so close to residential homes, the use of herbicide may not be a viable option for weed control, thus preventing weed establishment is the best and most economical opportunity for weed management. Unmitigated, the spread of weedy species in reclaimed areas would be an adverse, minor, permanent and predictable impact on habitat values and maintenance costs.

Mitigation Measures and Residual Impact

Precautions, such as cleaning construction equipment and vehicles used in weedy areas before moving into new construction areas will help reduce the potential transfer and spread of weedy species. Some weed-control may be required until desired vegetation becomes established, but the need for such measures can be assessed through monitoring. An action plan will be developed to control spread of noxious, restricted and nuisance weeds. The City shall issue a Final Acceptance Certificate to the contractor if all observed defects in the work have been corrected to the City's satisfaction, including unacceptable levels of weeds. Considering these measures, the residual impact will be negligible.

6.1.5.5 Accidental contaminant spills

Impact

Fuel or lubricant spills can occur during refueling or as a result of equipment failure or accidents (e.g., broken hydraulic hose). Should spills occur in areas with natural vegetation or on exposed soils, these features could be contaminated with hydrocarbon and heavy metals which, in turn, could result in plant mortality. Most spills would likely be small in nature but if uncontrolled, could spread over large areas.

Equipment used for this project will be refueled and maintained at a central location that is more than 100 m away from any watercourse and preferably on a paved or graveled area. If fuel is

stored on-site, tanks will be secured and have some form of spill protection (e.g., spill pan). Spill kits will be carried or readily accessible to equipment working on-site and at the refueling/maintenance area. Construction personnel will be trained in the use of spill kits. Should a spill occur, personnel will be instructed to immediately contain and attempt to prevent the spread of the spilled material, particularly if near the storm water outlet structures, to avoid having fuel or lubricants flow into the North Saskatchewan River. With these measures implemented, the impact of a contaminant spill on vegetation will be negligible.

Mitigation Measures and Residual Impact

No further mitigation is required beyond the standard measures described above. The residual impact will be negligible.

Potential impacts, mitigation measures and residual impacts are summarized in Table 6.6.

Table 6.6 Review of impacts analysis for vegetation

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Loss of native vegetation	Adverse, major, permanent, predictable	• Develop a Landscape Plan and Landscape Maintenance Plan, which will be approved by Edmonton Parks Branch • Monitor and maintain revegetated areas for one year according to Landscape Plan	Adverse, minor, short-term to long-term, predictable
Loss of trees	Adverse, minor, short-term to long-term, predictable	• Replace trees pursuant to the Corporate Tree Management Policy • Relocate four spruce trees in the upper Main ravine	Adverse, minor, short-term to long-term, predictable
Disturbance to manicured areas	Adverse, minor, temporary, predictable	• Construction contractor will revegetate disturbed areas with sod or appropriate species according to landscape plan. • Monitor and maintain revegetated areas for one year according to Landscape Maintenance Plan, which will be	Negligible

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
		approved by Edmonton Parks Branch	
Introduction of weedy or invasive species	Adverse, minor, permanent, predictable	• Develop action plan to control spread of weedy species in reclaimed areas • Clean construction equipment previously used in weedy areas before moving into the Lynnwood Ravine • Use weed control on soil stockpiles left for long periods • Use weed control in disturbed areas until desired vegetation established	Negligible
Accidental contaminant spills	Negligible	• Standard construction practices • Maintain and refuel equipment at least 20 m from the ravine outlet structures • Store on-site fuels in secure tanks with some form of spill protection • Ensure spill kits are readily available at refueling/maintenance area • Train personnel in use of spill kits and immediate response	Negligible

6.1.6 Wildlife

Potential impacts related to wildlife from the proposed project include the following:

- Loss of wildlife habitat through vegetation clearing.
- Construction disturbance and species alienation.
- Wildlife mortality caused by vegetation clearing.
- Wildlife mortality due to water ponding.

- Loss of special status species.

6.1.6.1 Loss of wildlife habitat through vegetation clearing

Impact

The diversity of natural vegetation within the Lynnwood Ravine provides suitable habitat for many wildlife species. Any loss of natural vegetation will, therefore, constitute an associated loss of natural habitat. Construction activities will not remove any wildlife habitat in the Main ravine except for 4-5 small trees located in the open, manicured grassland of the ravine bottom which will be relocated within the ravine proper.

Clearing of some vegetation will be required for the LY4 project. Depending on the microtunnel construction method used, the building of either 2 or 3 vertical working shafts will be required, as follows:

- A 7 m wide shaft located partly on 83rd Avenue and partly on the adjacent manicured grassland,
- A similar-sized shaft located in the manicured grassland in the bottom of the Main ravine, and
- A possible third shaft, (to be constructed if hand tunneling methods are used) will be located within the vegetation at the intersection of 82nd Avenue and Lynnwood Way.

The majority of vegetation clearing for the LY3, LY4 and LY2B projects will occur within the manicured grasslands, with relatively small areas of natural vegetation being cleared. As such, impacts to wildlife habitat would be adverse, minor, short-term to long-term and predictable.

Mitigation Measures and Residual Impact

Prior to construction, marking the clearing limits with snow-fence or highly-visible flagging will help minimize the extent of habitat loss. Until detailed designs of both projects are confirmed, the residual impact will remain adverse, minor, short-term to long-term and predictable.

6.1.6.2 Construction disturbance and species alienation

Impact

The activity and noise associated with construction can inhibit sensitive wildlife species from using adjacent habitat. This habitat alienation effect reduces the amount of habitat available to individuals and could impede movement for medium-sized animals, although in the case of construction, the impact will be temporary.

Most of the wildlife species using habitat in the study area have likely adapted to some human disturbance because of the surrounding residential development and ravine recreation use. In that context, any additional disturbance caused by construction activities or increased numbers of people in the area is likely to be minimal. The potential for construction activities to result in habitat alienation would be adverse, minor, short-term, and predictable.

Mitigation Measures and Residual Impact

To mitigate the effect of disturbance and habitat alienation, particularly on species that are sensitive to disturbance, the areal extent of construction activities within the Lynnwood Ravine will be kept to a minimum. The resulting residual impact would be negligible.

6.1.6.3 Wildlife mortality caused by vegetation clearing

Impact

Clearing of natural vegetation can cause wildlife mortality, particularly if sites are cleared at a time when mobility is restricted, such as during the spring breeding period. At these times, adults remain close to den and nest sites and young are not yet able to move long distances. Vegetation clearing will destroy nests, resulting in mortality of young and a decrease in reproductive success. If mortality is high during the spring breeding period, local populations can suffer a short-term decline, an effect even more dramatic in populations already at low levels (i.e., special status species). Migratory birds are protected under the federal Migratory Birds Convention Act (MBCA) and the Alberta Wildlife Act, which states that nests cannot be disturbed or removed during breeding season. A recent amendment to the *MBCA* further protects disturbance to individual migratory birds. Direct mortality and nest site disturbance resulting from construction activity and clearing would contravene those Acts. The impact of removing nest trees or destroying the nesting habitat of shrub or ground nesting species will be adverse, major, short to long-term and predictable.

Mitigation Measures and Residual Impact

There are two ways of mitigating the impacts of construction activities on breeding birds. The first is to limit construction to time periods outside of the breeding season for birds in this region. This period would run from 15 April to 31 July (some species may have nestlings into the month of August, depending on the environmental conditions of the nesting season, i.e., weather, food supplies, etc). The second is to limit the construction to those areas where birds are unlikely to nest, which in this case would be the manicured habitat of the ravine bottom. As the exact site of open trenching (Main ravine) and vertical shaft placement (Small ravine) is not known at this time, the best option would be to limit the temporal extent of construction activities to minimize effects on nesting birds. With this measure in place, the effects would be negligible.

6.1.6.4 Wildlife mortality due to water ponding

Impact

Water ponding in the Main ravine during extreme precipitation events (such as the one which occurred during July of 2004) would cause mortality to bird species which nest either in low shrubs or on the ground. It would also cause mortality to those small mammal species which are unable to climb trees. A local die-off event such as this has the ability to adversely affect proper ecosystem functioning in the ravine, with both predators (eg., insectivorous birds) and prey (eg., small mammals) being affected. Water has to be removed from the lower end of the Small ravine as quickly as possible, to prevent unusually high water accumulations which could spread from the manicured grassy areas in the bottom of the ravine and into the wooded ravine side slopes, where the highest levels of wildlife biodiversity would be found. The current impact of high

levels of ponded water in severe storm events would be adverse, minor, short to long-term and predictable.

Mitigation Measures and Residual Impact

The proposed project will increase the ability of the existing storm trunks to move floodwaters from the Lynnwood storm trunk into the Lynnwood Ravine and then out of the Lynnwood Ravine at a faster rate than before. Levels of ponded water should be lower and the reduced retention time for ponded water may reduce the adverse impact experienced with the current drainage scenario. Considering the low frequency of severe storms and the improvements made, however, the impact will be negligible.

6.1.6.5 Loss of special status species

Impact

Although some clearing of native habitat is expected to occur within the Lynnwood Ravine the extent of that clearing will be minimal because construction activities will occur mainly within the manicured grasslands. (Until detailed designs are available, the exact amount of treed habitat to be cleared is not known). As such, it is unlikely that construction activities have the potential to directly impact any of the special status avian species known or suspected to use habitat in the regional study area. Construction may, however, alienate some special status species that use the area.

Of the special status species potentially using habitat in the Lynnwood Ravine, only a few of them stand a significant chance of being negatively affected. The Pileated Woodpecker is an uncommon bird within the Edmonton region and signs of its presence were found in the Lynnwood Ravine. This species requires mature Aspen and Balsam Poplar trees, which are found within the ravine and also in the nearby North Saskatchewan River Valley.

The Western Small-footed Bat (Table 5.11) and Northern Bat (Appendix J) are two species which could potentially use the Lynnwood Ravine for roosting sites during the spring and summer months. Roosts are generally located in large deciduous trees, which would be impacted if construction activities had to remove them.

The Long-tailed Weasel (Appendix J) is the one predatory mammal which may be found in the Lynnwood Ravine as the ravine is large enough to accommodate its home range. Larger mammals would need a larger habitat and there is no unbroken green corridor linking the Lynnwood Ravine with any other natural habitat.

The impact of construction activities on rare or special status species would be adverse, minor to major, short to long-term and predictable.

Mitigation Measures and Residual Impact

Confirm areas of native vegetation to be cleared during the detailed design phase of project. Avoid vegetation clearing during the breeding bird season (15 April to 31 July). Considering these measures, the residual impact would be reduced to negligible.

Potential impacts, mitigation measures and residual impacts are summarized in Table 6.7.

Table 6.7 Review of impacts analysis for wildlife

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Loss of wildlife habitat	Adverse, minor, short-term to long-term, predictable	• Confirm areas to be cleared once detailed design complete • Mark clearing limits prior to clearing • Revegetate any disturbed areas as soon as possible using native species similar to pre-construction vegetation communities	Adverse, minor, short-term, to long-term, predictable
Species alienation	Adverse, minor, short-term, predictable	• Keep extent of construction activities to a minimum	Negligible
Wildlife mortality due to vegetation clearing	Adverse, major, short to long-term, predictable	• Avoid clearing in the period 15 April to 31 July • Mark clearing limits prior to clearing	Negligible
Wildlife mortality due to water ponding	Adverse, minor, short to long-term, predictable	• Increase size of outlet structure • Strategic placement of outlet structure	Negligible
Loss of special status species	Adverse, minor to major, short to long-term, predictable.	• Avoid clearing in the period 15 April to 31 July	Negligible

6.2 Socio-Environmental Resources

6.2.1 Land Disposition and Zoning

Impact

There will be no change in land ownership for this project and no need for zoning changes. All of the proposed construction work, including the staging areas, would be on lands owned by the City, and no zoning changes would be required for the work to proceed. No impacts are anticipated.

Mitigation Measures and Residual Impact

No mitigation measures are required and the residual impact remains negligible.

6.2.2 Utilities

Potential impacts related to utilities from the proposed project include:

- Damage to utilities from construction traffic.
- Removal/realignment of existing utilities.

6.2.2.1 Damage to utilities from construction traffic

Impact

Accidental damage to a utility could create a risk to worker and public safety. One example might be damage to a power line, resulting in loss of service to residents and a safety hazard to workers. Impacts from this kind of accident would be adverse, minor to major, short-term and predictable.

Mitigation Measures and Residual Impact

Implementation of Best Management Practices for construction activities at the start of the improvement projects will minimize the chances of accidental damage to existing utilities. With this measure in place, the impact will be negligible.

6.2.2.2 Removal/realignment of existing utilities

Impact

There is a sanitary sewer line and several water main connectors located close to the proposed location of the LY4 project. The exact position of these utilities will be addressed in the detailed design and flagged prior to construction. Assuming that there were conflicts between existing and proposed utilities, any impacts resulting from having to realign the existing utilities would be adverse, minor, short-term and predictable.

Mitigation Measures and Residual Impact

A hydrovac will be required to determine the exact location of each utility. Best Management Practices, combined with First Call procedures, will be implemented prior to construction. As such, the potential for damage to a utility line is negligible.

Potential impacts, mitigation measures and residual impacts are summarized in Table 6.8.

Table 6.8 Review of impacts analysis for land disposition/zoning

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Damage to utilities from construction traffic	Adverse, minor to major, short-term, predictable.	• Implement Best Management Practices	Negligible
Removal/realignment of existing utilities	Adverse, minor, short-term, predictable.	• Implement Best Management Practices • Implement First Call procedures	Negligible

6.2.3 Recreational Land Use

Potential impacts related to recreational land use are limited to reduced access to some areas of the ravine during construction and reclamation.

6.2.3.1 Ravine access and use during construction

Impact

For the duration of the construction period, recreationists will have to avoid certain parts of the Lynnwood Ravine during open trenching operation. This is especially true in the upper Main ravine due to the open trenching method which will be used. However, this impact will be adverse, minor, short-term and predictable.

Mitigation Measures and Residual Impact

As a courtesy to recreationists, prior to construction and in consultation with Community Services, signs notifying people of the ravine closure will be installed at strategic locations along the Main and Small ravines. A public mail-out to area residents should be performed in advance of construction. Notification should include information on nature of work to be performed, construction start date, approximate duration, and a contact number for inquiries. With these measures in place, the residual impact to the Lynnwood Ravine access by nearby residents will be adverse, minor, short-term, predictable.

6.2.3.2 Ravine access and use during reclamation

Impact

Vegetation clearing, trenching, vertical shaft construction, vehicle access and landscaping will cause localized surface disturbance to the Lynnwood Ravine. Intensive reclamation work will be required to restore the native and manicured vegetation. This is especially true in the areas of manicured grassland which experience most of the use by nearby residents. Recreationists will be unable to access those areas of the ravine where reclamation structures are put in place. The impact will be adverse, minor, short to long-term and predictable.

Mitigation Measures and Residual Impact

Area residents will be informed by Drainage Services about reclamation plans and progress. Signs will be erected alerting the ravine users about the reclamation practices being used and which activities are unacceptable in reclaimed areas, at least until the affected areas have been restored to their previous state. A monitoring program will be instituted to ensure that reclamation activities are having the desired effect and to deal with any unforeseen future problems. With these measures in place, the impact will be negligible.

Potential impacts, mitigation measures and residual impacts are summarized in Table 6.9.

Table 6.9 Review of impacts analysis for recreational land use

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Ravine access and use during construction	Adverse, minor, short-term, predictable	• Post warning signs in advance of ravine closure • Maintain communication with local residents through public mail-out of information notices.	Adverse, minor, short-term, predictable
Ravine access and use during reclamation	Adverse, minor, short to long-term, predictable	• Post information signs in the ravine • Maintain communication with local residents • Creation of a site-specific reclamation plan • Monitoring program following a landscape architect-recommended planting schedule	Negligible

6.2.4 Residential Land Use

Potential impacts related to residential land use from the proposed project include the following:

- Traffic and parking disruptions due to construction.
- Damage to roads.

6.2.4.1 Traffic and parking disruptions due to construction

Impact

Except for a minor amount of traffic due to trucks turning from 156th Street into the Lynnwood Ravine (and from the ravine onto 156th Street), normal traffic will not be disrupted by construction in the Lynnwood Ravine as all related activities and material laydown areas will be located within the ravine itself. The LY4 & LY2A projects will disrupt traffic and parking along 84th Avenue where the working shafts will need to be located. The size of the shaft will most likely require the closure of most, if not all, of the residential street. The impacts to traffic and parking from the LY4 & LY2A projects would be adverse, minor, short-term and predictable.

Mitigation Measures and Residual Impact

Hoarding or fencing will be erected around the shaft and appropriate safety features will be put in place to direct traffic around the shaft. Communication with nearby residents will be necessary as they will be directly affected by the temporary loss of street space. With these measures in place the residual impact will be adverse, minor, short-term and predictable.

6.2.4.2 Damage to roads

Impact

Construction traffic will likely access the Lynnwood Ravine via either 156th Street or 83rd Avenue. The LY12 & LY3 projects will require several large pieces of equipment, including front-end loaders, transport trucks and gravel trucks. Soil removal from the open trench and the ravine surface landscaping will most likely require numerous trips by heavily loaded gravel trucks. The LY4 & LY2A projects will require the transport of several large pieces of equipment and short-distance transport of soil from the vertical working shafts. These activities could lead to damage to the surface of the residential roads. The potential for roads to be damaged from construction traffic is considered an adverse, minor to major, permanent and uncertain impact.

Mitigation Measures and Residual Impact

A Best Management Practices plan will be incorporated into the construction plan and designed to ensure that road damage caused by trucks and associated construction machinery is minimized. Clods from gravel truck tires that accumulate on the road surface will be cleaned to avoid build-up. With these measures in place the impact will remain adverse, minor, permanent and uncertain.

Potential impacts, mitigation measures and residual impacts are summarized in Table 6.10.

Table 6.10 Review of impacts analysis for residential land use

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Traffic and parking disruptions due to construction	Adverse, minor, short-term, predictable.	• Erect safety fencing around shaft. • Maintain communication with affected households	Adverse, minor, short-term, predictable.
Damage to roads	Adverse, minor to major, permanent, uncertain	• Implement Best Management Practices plan. • Keep soil clods off adjacent roads	Adverse, minor, permanent, uncertain

6.2.5 Noise

Potential impacts related to noise from the proposed projects include increased noise from construction activities.

6.2.5.1 Noise from construction activities

Impact

Residents living in homes adjacent to the Lynnwood Ravine could potentially be impacted by construction related noise and activity as could area residents using the ravine. Depending on the location of residences and type of construction activity, the severity of adverse impacts from construction noise would vary considerably. Passive activities such as reading in the backyard or recreational pursuits such as nature appreciation would most likely be affected, while more active pursuits such as walking or hiking would be affected to a lesser extent. However, in all cases, the impacts would be adverse, minor, short-term and predictable.

Mitigation Measures and Residual Impact

Construction noise will be limited to the hours permitted by the City Noise Abatement Bylaw 7255 (7 a.m. – 10 p.m.) and appropriate noise abatement measure will be employed in the event that noise levels exceed bylaw thresholds. Even with those mitigation measures employed, residual impacts to residents and recreationists from noise will remain adverse, minor, short-term and predictable.

Potential impacts, mitigation measures and residual impacts are summarized in Table 6.11.

Table 6.11 Review of impacts analysis for noise

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Noise from construction activities	Adverse, minor, short-term and predictable	• Comply with City of Edmonton Noise Bylaw 7255 • Employ noise abatement measures as required	Adverse, minor, short-term, predictable

6.2.6 Worker and Public Safety

Potential impacts related to worker and public safety from the proposed project include:

- Staging/Construction hazards to public safety.
- Wildfires caused by construction equipment.

6.2.6.1 Staging/Construction hazards to public safety

Impact

The presence of a construction site with open pits (trench, shaft) within a recreationally-used green space poses a potential public safety risk. Without proper delineation of safe areas during construction activities, members of the public could become injured by wandering into the construction zone.

Posting warning signs near the staging areas, construction traffic access points and active work sites that are freely accessible to the public will alert the public to the temporary construction activities. Safety fences will be erected at all construction areas to prevent access to open pits. Appropriate recreational trail detours will be clearly indicated. With these protective measures in place, the impact of construction activities and staging areas to public safety will be negligible.

Mitigation Measures and Residual Impact

No further mitigation is required and the residual impact would remain negligible.

6.2.6.2 Wildfires caused by construction equipment

Impact

The Lynnwood Ravine is heavily wooded along the sides of the Main ravine and throughout the Small ravine. The ravine bottom is mowed grass that, by the middle if the summer, has a significant build-up of dried, cut grass. In dry conditions, these two factors (dry grasses and woody vegetation) would present a ready fuel load for wildfires.

An accidental fire ignited by sparks from machinery, construction materials or workers' cigarettes could spread quickly. Houses adjacent to Lynnwood would be at risk in the event of a

large, fast-spreading fire, especially given that they are located very close to any initial fire ignition sites. In most cases, wildfires would result in extensive damage to the vegetation and forests of the ravine. In the worst-case scenario, property damage, injury or loss of life could result. City fire crews are nearby (within one kilometer) and could respond quickly if a fire did begin. In either case, the impact would be adverse, major, short to long-term and predictable.

Mitigation Measures and Residual Impact

The following measures will help reduce the potential for construction activities, vehicles or personnel to initiate a wildfire:

- Fire fighting equipment will be available near any flammable storage sites, including fuels, lubricants and other petroleum projects.
- Smoking on the construction site will be prohibited, particularly near fuel storage areas or in treed areas. A designated smoking area will also be established.
- A procedure for on-site fire response will be developed and communicated to all site personnel. That plan will include contact information for local fire and emergency departments.
- The contractor will advise the Edmonton Fire Department of the situation with regards to potential wildfires in the Lynnwood Ravine and keep them updated on their construction schedule.

With these mitigation measures in place, the residual impacts will be negligible.

Potential impacts, mitigation measures and residual impacts are summarized in Table 6.12.

Table 6.12 Review of impacts analysis for worker and public safety

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Staging/Construc-tion hazards to public safety	Negligible	• Post signs and erect safety fences at all construction areas that will be freely accessible to the public	Negligible
Wildfires caused by construction equipment	Adverse, major, short to long-term, predictable	• Make firefighting equipment available near flammable storage sites • Prohibit smoking except in designated areas • Develop procedures and contact information for fire response • Maintain communication with the Edmonton Fire Department	Negligible

6.2.7 Visual Resources

Potential impacts related to visual resources from the proposed project include:

- Reduced quality of views into the ravine from adjacent residential homes.
- Reduced quality of aesthetics within the ravine.

6.2.7.1 Views from the adjacent residential communities

Impact

Views into the Lynnwood Ravine from adjacent residential areas are obscured by the forests along the sides of the ravine and, because the ravine is lower than the surrounding lands, views into the ravine from its western and southeastern ends are limited. The proposed outlet or inlet structures will not be visible from outside of the ravine. The number of smaller trees requiring removal will not significantly affect the overall landscape of the ravine. The impact to views from adjacent residences will, therefore, be negligible.

Mitigation Measures and Residual Impact

Construction time will be minimized to reduce the temporary impact from residents being able to see construction equipment. Disturbed areas will be reclaimed as quickly as possible and residual visual impacts will lessen as the new landscaping, using both native and cultivar species, matures. Depending on final detailed landscape design, the residual impact to Lynnwood residents will remain negligible.

6.2.7.2 Views within the ravine

Impact

Undesirable, temporary views within the Lynnwood Ravine will occur as a result of the presence of construction equipment. The removal of manicured grass and top soil will create an undesirable visual component to the natural greenscape of the ravine. And while the inlet and outlet structures will be larger than those presently in place, they will both be level with the ground surface or extend only a few centimeters above it. These changes to the visual quality of the ravine will be adverse, major, short-term and predictable.

Mitigation Measures and Residual Impact

Landscaping of the disturbed areas used for replacing and/or placing new storm water pipelines will be required, as will the area of the inlet structure which will require some ground surface sculpting. Landscaping will be done according to a planting schedule recommended by a landscape architect and a one-year monitoring program will be implemented to monitor the landscaping success. With those measures in place the residual impacts will be adverse, minor, short to long-term and predictable.

Potential impacts, mitigation measures and residual impacts are summarized in Table 6.13.

Table 6.13 Review of impacts analysis for visual resources

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Views from the adjacent residential communities	Negligible	• None	Negligible
Views within the ravine	Adverse, major, short-term, predictable	• Implement landscape architect recommended planting schedule. • Implement reclamation monitoring program.	Adverse, minor, short to long-term, predictable

6.2.8 Heritage Resources

Potential impacts related to heritage resources from the proposed project include:

- Disruption to, or destruction of, historical resources.

6.2.8.1 Disruption to, or destruction of, historical resources

Impact

Excavation for the open trench of LY3 project and the working shafts for LY4 & LY2A projects have the possibility for disturbing previously undiscovered historical sites. However, no known historic or archaeological sites have been reported for the Lynnwood Ravine. All of the Main ravine, and much of the Small ravine, has previously been disturbed by construction activities and up to 2.0 m of fill placed on the ravine floor. Because all of the excavating activities will occur within this layer of fill, the potential for disturbing any previously undiscovered historical sites is negligible.

Mitigation Measures and Residual Impact

If archaeological, paleontological or historical resources are encountered during the LY3 and LY4 construction activities, Alberta Community Development should be notified immediately. The residual impact remains negligible.

Potential impacts, mitigation measures and residual impacts are summarized in Table 6.14.

Table 6.14 Review of impacts analysis for heritage resources

Impact Description	Impact Characteristics	Mitigation Measures	Residual Impact Characteristics
Disruption to, or destruction of, historical resources	Negligible	• If potential heritage resources discovered, suspend work and contact Alberta Community Development and Royal Alberta Museum	Negligible

7.0 SUMMARY ASSESSMENT

7.1 Summary of Residual Impacts

Residual impacts (those predicted to occur with mitigation in place) are the "bottom line" of an ESR. Residual impact severity was defined as follows:

> **Minor Impact:** An interaction that has a noticeable effect but does not affect local or regional populations, natural or historical resources or physical features beyond a defined critical threshold (where that exists) or beyond normal limits of natural perturbation. Also, an interaction that does not alter existing or future recreational pursuits at established facilities or well-used areas.
>
> **Major Impact:** An interaction that affects local or regional populations, natural or historical resources, or physical features beyond a defined critical threshold (where that exists) or beyond the normal limits of natural perturbation; or alters existing or future recreational pursuits at established facilities or well-used areas.

The reader is referred to the individual impact analysis summary tables provided in Chapter 6 for a full description of all residual impacts.

7.1.1 Positive Impacts

There are two potentially positive impacts:

- The potential for slope failure resulting from storm water ponding will be reduced. That is rated as a minor, long-term and predictable impact.
- A decrease of residence flooding due to storm water ponding. That is rated as a major, long-term and predictable impact.

7.1.2 Adverse Impacts

There are eight potential impacts that are rated as adverse and are categorized as shown in the table below.

Table 7.1 Summary of adverse impacts resulting from the LY3 & LY12, LY4 and LY2A projects

Impact Characteristics	Impact Description
Minor, short-term and predictable	• Reduced ravine access and use during construction • Traffic and parking disruptions due to construction • Noise from construction activities
Minor, short-term to long-term and predictable	• Loss of native vegetation • Loss of wildlife habitat • Loss of trees • Minor alteration of views within the ravine
Minor, permanent and uncertain	• Damage to roads

7.2 Monitoring

The following construction and post-construction monitoring initiatives will be included as part of the project and will be included in those plans. Some of those monitoring programs are noted in Chapter 6 as mitigation measures.

7.2.1 Soils

Monitor the progress of revegetation in disturbed areas

7.2.2 Vegetation

Monitor and maintain revegetated/reclaimed areas for one year according to Landscape Plan

7.3 Issues Resolution

Chapter 4 presented a series of issues related to the improvement projects for both the storm and sanitary infrastructure. This section revisits each of those issues and describes how they were/will be addressed. This discussion is organized by subject area.

7.3.1 Geomorphology/Terrain

In the event of the ravine being filled with water as a result of a severe storm, will there be significant erosion of the ravine side slopes?
Probably not and two factors must be considered:

- This event would require another 1:100 to 1:200 year storm, which is a small possibility.
- Enlarging the existing outlet pipe will minimize the retention time that ponded water is in contact with the ravine side slopes.

These factors reduces the potential for significant side slope erosion to be triggered.

7.3.2 Soils

Will construction result in the loss of topsoil, or degrade soil quality, in turn affecting reclamation?
No. The existing topsoil from the trenched and landscaped areas will be removed and replaced by clean black soil, which will aid successful reclamation efforts.

Will use of staging areas for fuel, lubricants and other contaminants pose a risk of soil contamination?
Yes, but all staging areas in which fuels or lubricants will be used will be in protected areas which will limit the risk of soil contamination.

Will construction equipment result in soil compaction along temporary access routes?
Yes, however a site-specific reclamation and landscaping plan to be used by the construction or landscaping contractor will adequately address this issue.

Will there be a problem with disposal of extracted soil due to possible contamination of that soil as a result of it being brought in for fill in the ravine bottom from an unknown site?

This is a possibility because foreign materials were found in the boreholes, down to a depth of 2.0 m. But a soil sampling and testing protocol performed by an accredited soil testing laboratory will be able to determine the soils' status. Any contaminated soil will be disposed in an appropriate facility depending on the results of the toxicological assays.

If there is a severe rainstorm during construction, would significant amounts of loose sediment at the surface flow into the storm drainage system and then into the North Saskatchewan River?
No. Erosion and sedimentation control protocols have been incorporated into preliminary design plans. Those protocols include dampening disturbed surfaces to guard against wind erosion, covering stockpiled fill and topsoil, diverting surface flow around working areas and erecting silt traps to prevent any eroded material from getting into the storm sewer.

Further, there is a decreased likelihood of severe storm events in the second half of August, which is the proposed time period for the start of construction activities.

For the stormwater overflow structure in the Main ravine, will a high outflow of surface water due to a severe storm result in serious surface erosion further down the ravine?
No, surcharged water outflow onto the surface of the Main ravine should not result in serious surface erosion once the landscaped areas of this ravine have been reclaimed. That is because the hydraulic (slope) gradient in that part of the ravine is very low and the landscaped vegetation will hold surface soil in place.

7.3.3 Hydrology and Surface Water

Because there is no surface water in the Lynnwood Ravine, there are no issues with regard to disrupting a watercourse. However, flowing water at the surface could be present during a severe storm event. This concern is dealt with in previous sections on soils (Section 7.3.2) and project scheduling (Section 2.3.8).

7.3.4 Air Quality

Will dust generated by construction traffic and construction activities pose a health risk to residents and nearby recreational users?
Dust generated by construction activities will be limited in both spatial scope and during a relatively short time frame. The amount of dust generated by the LY3 or LY4 projects should not be excessive and therefore, not a significant health issue for nearby residents.

7.3.5 Vegetation

Will the project result in significant disturbance to native vegetation communities?
No, as the majority of construction activities will occur in the manicured, non-native grasslands.

Does the project have potential to affect rare, threatened or endangered plants or unique vegetation communities?

There are no unique plant communities within the Lynnwood Ravine and it is highly unlikely, given the types of native plant communities present, that there are any rare plants in the Lynnwood Ravine.

Will disturbance to the surface vegetation result in a significant increase in the ability of invasive or noxious weeds to become established within the ravine?
Yes. There are already areas along the Main ravine which have dense patches of invasive and non-native plants, particularly Canada Thistle. Immediate reclamation of disturbed sites after construction is complete will help minimize the establishment of invasive plant species.

Will native or ornamental trees on City lands be removed or damaged during construction? How will any loss be compensated for as required by the Corporate Tree Management Policy?
The position of the open trench used to install the LY3 stormwater pipe will require the relocation of 4 small spruce trees. The exact positions of the working shafts for the LY4 project are not yet known but they may require the temporary (or perhaps permanent) removal of up to several large trees. City of Edmonton foresters will have to determine the appropriate compensation for lost trees once the detailed design plans have been completed.

7.3.6 Wildlife

How much existing wildlife habitat will be removed for the project and what types of habitat?
Because the LY3 project will occur within the manicured grasslands, very little wildlife habitat will be affected by this project. The LY4 project has the potential to impact some wildlife habitat but this will be minimal in scope because the area to be disturbed will be small and there is identical wildlife habitat close by to serve as escape habitat for any affected wildlife species.

Will any rare, threatened or endangered wildlife be affected by construction activities?
This is highly unlikely, due to a paucity of wildlife species in the Lynnwood Ravine which could be considered as rare, threatened or endangered.

Will construction activity within the Main and Small ravines result in alienation of wildlife, especially considering that there is little, easily accessible wildlife habitat nearby?
The construction activity will result in some wildlife species alienation but that will be a short-term and temporary effect.

Will wildlife movement be blocked or impeded by construction activities?
Yes, but this will a short-term and temporary effect and, given the low biodiversity of wildlife in a ravine of this size which is surrounded by dense residential communities and a very busy freeway, this is not considered a serious impact.

Will construction activities affect breeding success?
It has the potential to affect the breeding success of avian species. Limiting construction activities to time periods before and/or after the breeding season, and keeping activities away from native vegetation, will minimize this impact.

7.4 Socio-Environmental Resources

7.4.1 Land Disposition and Zoning

Is this project occurring on City owned property?
Yes.

Will land zoning changes or easements be required?
No; current land zoning and easements will remain the same.

Will any additional lands be required to construct the projects?
No; all activities associated with the improvement projects will occur within the area of the Lynnwood Ravine.

7.4.2 Utilities

Will any utilities be damaged, resulting in a risk to public safety?
There is the possibility that existing utilities could be damaged by hydrovac surveys as well as trenching operations, a fact acknowledged in the preliminary design reports produced by the project engineers. However, the probability of a problem resulting from the hydrovac surveys will be small and those surveys will ensure that damages to public utilities will be minimized.

Will any utilities be removed or realigned?
From the information available to date, there are no utilities which will need to be removed or re-alligned. However, if any are found during the detailed design phase, they will be flagged prior to construction.

7.4.3 Land Use

Will recreational users be affected by construction activities?
Yes, but this will be a temporary impact. Once the construction projects are complete, there will be no further impact on recreational users of the Lynnwood Ravine.

Will traffic disruption, including lane closures, be acceptable to motorists?
The LY12 & LY3 project will not have any appreciable impact on local traffic with the exception of minor and temporary traffic slowdowns due to trucks moving on and off 156th Street during construction hours. The LY4 & LY2A projects will require the closure of part or all of one avenue. This will be an inconvenience to the residents of that avenue but there is another ingress-egress route which local traffic can easily access.

Will construction activities damage roads used for construction access?
There is the potential for construction activities to damage local roads but if project engineers and construction workers take appropriate protective measures this should not be a significant impact.

Will construction activities result in damage to the landscape of the ravines?
The LY12 & LY3 projects will require some landscaping and re-contouring of the ravine ground surface. If done correctly, the result should not be considered a detrimental visual impact to recreational users of the ravine. Damage to the landscape of the ravine for the LY4 and LY2A projects will depend on the exact position of the working shafts within the ravine. Landscaping plans will be required to minimize the long-term damage to the ground surface.

7.4.4 Worker and Public Safety

Is there potential for staging and construction areas to compromise the safety of motorists?
Yes; but this could be minimal with the appropriate use of fencing, hoarding and informational signage.

Will construction increase the risk of wildfires occurring? Will fire fighters have access to all areas of the ravines?
Given the types of machinery which will be used in close proximity to heavily treed areas during the dry summer months, there is a risk of wildfires. This is a significant concern in that residential houses will be in close proximity to the initial ignition spots for these fires. Construction personnel will work closely with Edmonton Fire Department officials to ensure that fire fighters have access to all areas of the Lynnwood Ravine while construction occurs.

Is there a potential risk for pedestrians to fall into vertical working shafts?
Yes. The LY4 & LY2A project will require two, and perhaps three, vertical working shafts for the tunelling process. (The exact number of shafts will depend on the final project design). All vertical shafts will, however, be rendered inaccessible to pedestrians through the use of appropriate fencing and hoarding.

7.4.5 Visual Resources

How will construction activities and the installation of drainage structures affect the visual quality of the ravines?
The construction process will adversely affect the visual landscape of the ravines on a short-term basis. The installation of storm water outlet and inlet structures will have a minimal impact on the visual quality of the Lynnwood Ravine.

How will landscaping affect the visual quality of the ravines?
With appropriate landscaping and contouring, the visual landscape of the Lynnwood Ravine should not be compromised.

7.5 Heritage Resources

Will previously undiscovered artifacts be disturbed during subsurface construction activities?
It is highly unlikely that any previously undiscovered artifacts will be found during the construction phases of the improvement projects.

7.6 Conclusions

The purpose of the improvement projects is to reduce the flood potential in the Lynnwood Community. Once the projects are complete, that flood potential will have been significantly reduced. Several alternatives for installing the projects were considered and the selected options will result in the least amount of surface disturbance in the ravine possible. Further, the investigations identified a method of reducing repetitive surface disturbance in the ravine area by combining some aspects of the improvement projects(LY12 & LY3, LY4, LY2A & LY5B).

The principal attributes of the Lynnwood Ravine which characterize its natural environment are its small size, its lack of ecological linkages with other natural areas, and the fact it has been extensively landscaped in the past when the original storm water drainage system was installed. Additionally, it experiences a relatively low level of recreational use as a result of being isolated from existing trail systems in the NSRV.

As a result of these attributes, there is reduced potential for the improvement projects to create serious and lasting environmental impacts. This is due to the following factors:

- The construction of the LY3 trunk upgrade, enlarging the existing outlet pipe, installation of the inlet/overflow structure and landscaping will occur in manicured grasslands, which is a non-native habitat;
- Construction of the LY4 trunk upgrade and the LY2A sanitary sewer upgrade will use tunneling or hand-tunnelling methods and will thus, result in minimal damage to the natural forest;
- All construction projects will be of short duration and, with the exception of the open shaft on 84th Avenue, not be a direct negative impact on the area residents;
- Reclamation for the LY12 & LY3, LY4 and LY2A projects will be relatively straightforward; and
- Any environmental damage resulting from these projects will be easily remediated with the implementation of appropriate reclamation plans.

8.0 REFERENCES

8.1 Literature Cited

Acorn, J. 1993. Butterflies of Alberta. Lone Pine Press, Edmonton. 143p.

Alberta Sustainable Resource Development. 2000. The General Status of Alberta Wild Species. Alberta Environment /Alberta Sustainable Resource Development. Edmonton, AB.

Associated Engineering. February, 2006. West Edmonton Flood Relief Conceptual Design Report. Prep for City of Edmonton Drainage Services.

City of Edmonton. 2005. Erosion and Sedimentation Control Guidelines. Edmonton, Alberta. 73p.

Clean Air Strategic Alliance. 2006. Edmonton Air quality index report. http://www.casadata.org/airqualityindex/edmonton.asp

Earth Tech. November 2006. Lynnwood LY3/L13 ravine inlet/outlet controls project. Draft preliminary design report. Prep. for Drainage Services Branch, City of Edmonton. Rep. No. 94224-03. 12pp + appen.

EBA Engineering Consultants Ltd. October 2006. Geotechnical Evaluation, Proposed Lynnwood LY4 Storm Trunk Upgrade 82 Avenue and 152 Street, Edmonton AB. File No. 7100467. 10pp + figures, appen.

Environment Canada. 2007. Climate Data Online. National Climate Data and Information Archive. Maintained by the Meteorological Service of Canada, Environment Canada. Data accessed May 7, 2007. Website: http://www.climate.weatheroffice.ec.gc.ca/climateData/dailydata_e.html

EPEC Consulting Western Ltd. 1981. North Saskatchewan River Valley and Ravine System Biophysical Study. Inventory and Analysis Map Folio. Unpublished report prepared for City of Edmonton, Department of Parks and Recreation. Edmonton, Alberta.

Finlay, J.C. and T.W. Thormin. 1977. Breeding bird survey. Prepared for Alberta Environment. Edmonton, AB.

Fisher, C. and J. Acorn. 1998. Birds of Alberta. Lone Pine Publishing. Edmonton, AB.

Godfrey, John D. (ed). 1993. Edmonton beneath our feet. Edmonton Geological Society. Edmonton, AB.

Hilchie, G.J., N.G. Kondla, E.M. Pike, F.A. H. Sperling C.D. Bird. 1995. Alberta butterflies. The Provincial Museum of Alberta, Edmonton. 328p.

Natural Regions Committee 2006. Natural Regions and Subregions of Alberta. Compiled by D.J. Downing and W.W. Pettapiece. Government of Alberta. Pub. No. T/852.

Paquet, P., M.L. Gibeau, S. Herrerro, J. Jorgenson, and J. Green. 2004. Wildlife corridors in the Bow River Valleym Alberta: A strategy for maintaining well-distributed, viable populations of wildlife. A report to the Bow River Valley Corridor Task Force. Canmore, Alberta.

Pattie, D. and C. Fisher. 1999. Mammals of Alberta. Lone Pine Publishing. Edmonton, AB.

Phillips, D. 2004. The top ten Canadian weather stories for 2004. Canadian Meteorological Service, Environment Canada. URL: http://www.msc-smc.ec.gc.ca/media/top10/2004_e.html (Accessed October 17, 2006)

Russell, A.P. and A.M. Bauer. 2000. The Amphibians and Reptiles of Alberta. University of Calgary Press. Calgary, AB. 279p.

Sameng Inc. November 2006. Lynnwood LY4 Strm Trunk Upgrading Draft Preliminary Design Report. Prep. for Drainage Services Branch, City of Edmonton. Rep. File 817.

Semenchuk, G.P. 1992. The Atlas of Breeding Birds of Alberta. Federation of Alberta Naturalists. Edmonton, AB.

S.M.A. Consulting Ltd.. November 2006. Lynnwood LY3/L13 Ravine Inlet/Outlet Controls Project. Risk Assessment Report. Prep. for Earth Tech Canada Inc., November 7, 2006. 16p.

Smith, H.C. 1993. Alberta Mammals. Provincial Museum of Alberta. Edmonton, AB.

Spencer Environmental Management Services Ltd. 2002. Centennial Valley Properties Project Environmental review. Final Report. Prep. for Centennial Valley Properties Inc. June 2002. Project EP-138. 30pp + appen.

Strong, W.L. and J.M. Thompson. 1995. Ecodistricts of Alberta: summary of biophysical attributes. Pprepared for Alberta Environmental Protection, Resource Data Division. Edmonton, AB. Pub. No. T/319. 92p.

Thurber Engineering. September 11, 2006. Lynnwood Ravine Inlet/Outlet Controls Geotechnical Investigation. Report to Earth Tech (Canada) Inc. File No. 19-3485-96. 10pp + Figs.

Westworth and Associates. 1980. Environmental Inventory and Analysis of the North Saskatchewan River Valley and Ravine System – Vegetation and Wildlife. In: EPEC Consulting Western Ltd. 1981. North Saskatchewan River Valley and Ravine System Biophysical Study. Unpublished report prepared for City of Edmonton Department of Parks and Recreation. Edmonton, Alberta.

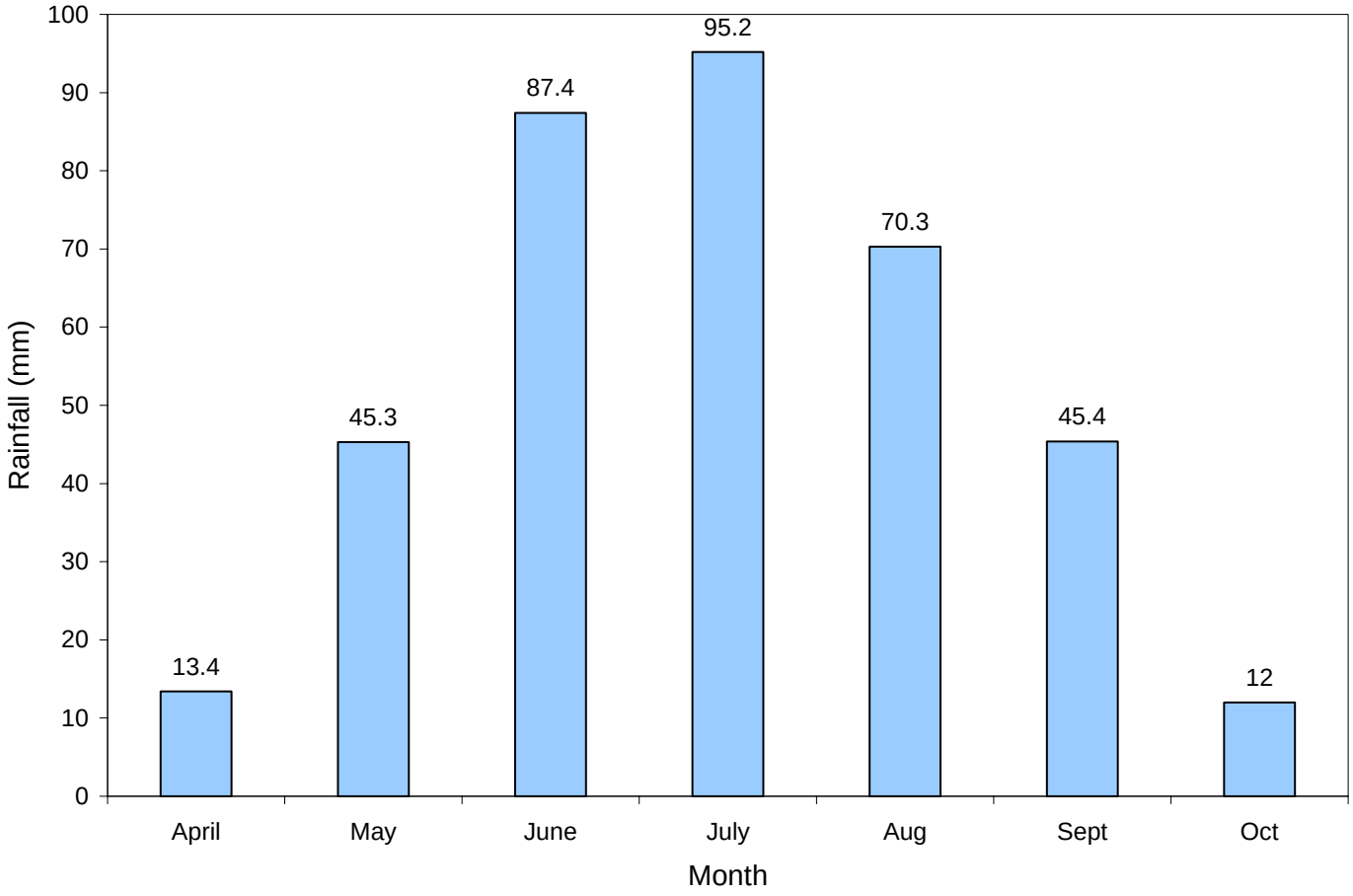
8.2 Personal Communication

Leonora Lumabi, P.Eng., Drainage Services, City of Edmonton.

Appendix A. Rainfall Data for the Edmonton Region

The information below illustrates the precipitation (rainfall) levels in the Edmonton region over the period of 1970-2006. This data was obtained from the climate normals data provided by the Meteorological Service of Canada (Environment Canada 2007). The weather station used for this data was located at the Edmonton International Airport.

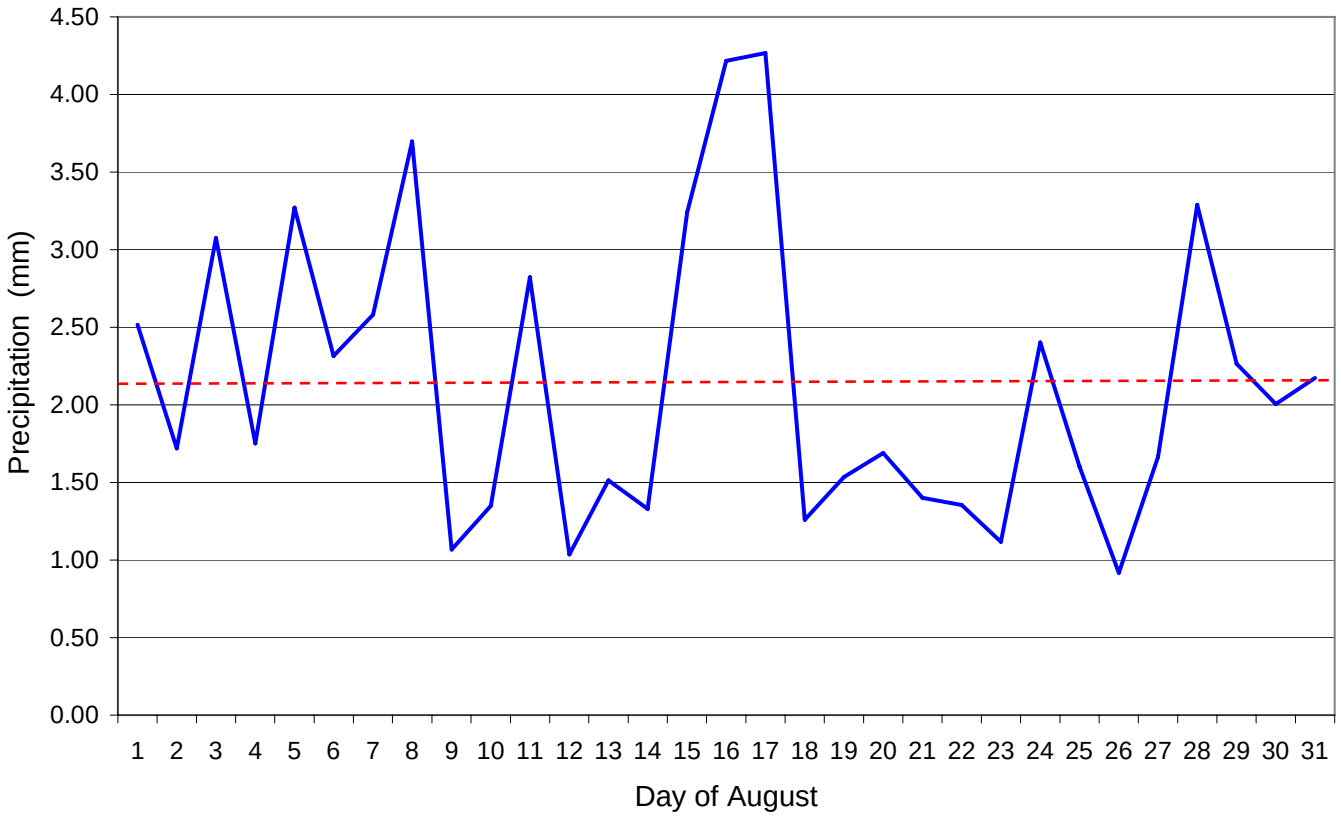
The following graph illustrates the level of non-winter season precipitation (rainfall) for the Edmonton region. The data are based on climate normals for the period of 1971-2000.



The data in the table below are mean daily rainfall amounts for the month of August, for the period of 1970-2006.

August Date	Mean Precipitation (mm)
1	0.03
2	0.05
3	0.08
4	0.11
5	0.14
6	0.16
7	0.19
8	0.22
9	0.24
10	0.27
11	0.30
12	0.32
13	0.35
14	0.38
15	0.41
16	0.43
17	0.46
18	0.49
19	0.51
20	0.54
21	0.57
22	0.59
23	0.62
24	0.65
25	0.68
26	0.70
27	0.73
28	0.76
29	0.78
30	0.81
31	0.84

The graph below uses the data from the preceeding table to illustrate Mean Daily Rainfall for each day in August, for the period 1970-2006. The dashed red line represents the mean precipitation level (2.14 mm) for the month of August (from 1970 to 2006).



Appendix B. Constructability and Risk Assessment Workshop for the LY3 Project

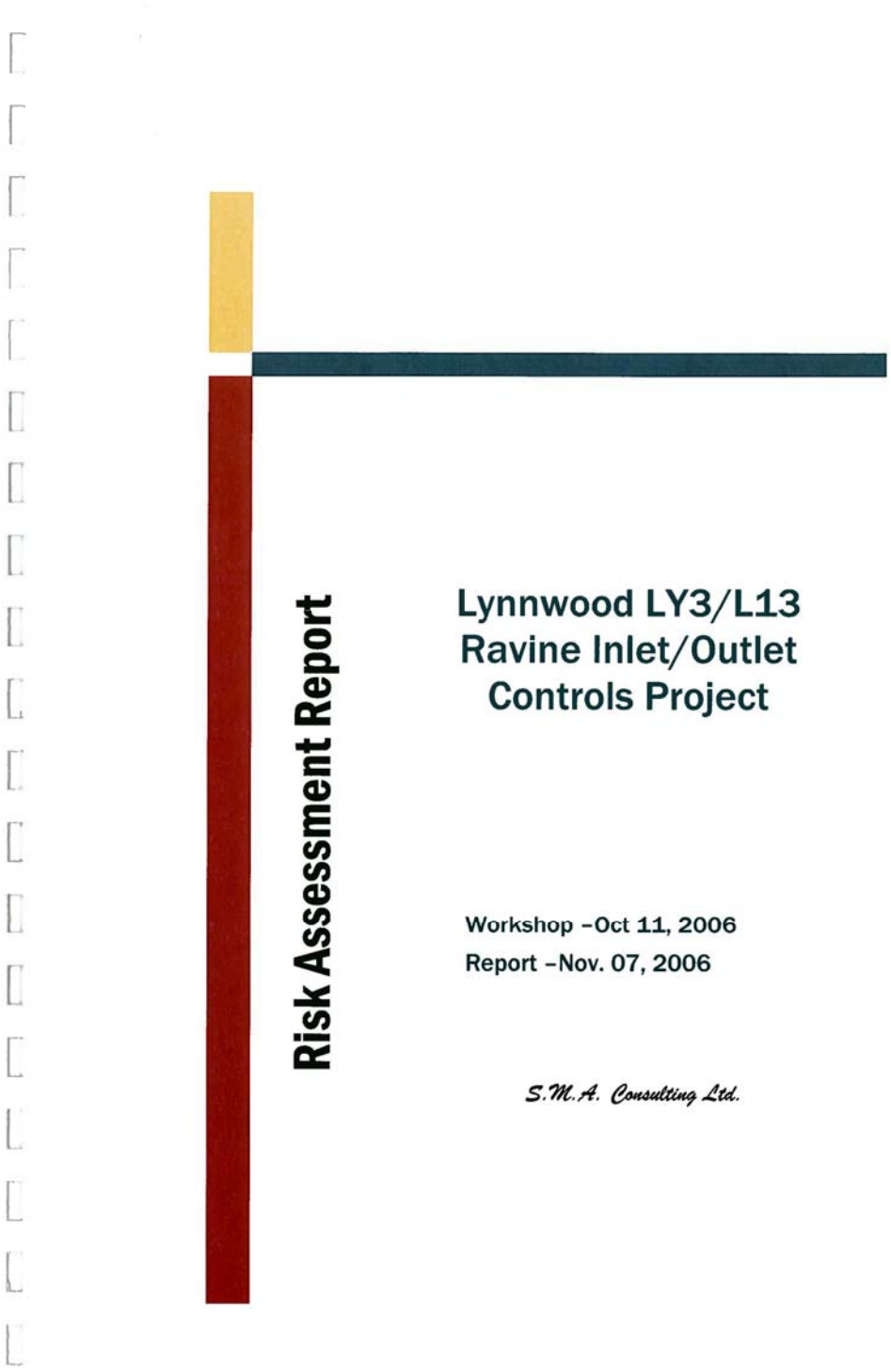
The Risk Assessment Workshop for the LY3 project was undertaken on 11 October 2006, and was facilitated by S.M.A. Consulting Ltd. The workshop consisted of determining the likelihood of a given risk factor being encountered during the project, the magnitude of the impact which would result if that factor was encountered and the production of an overall severity score to quantitatively rank the magnitude of various risk factors.

The following eighteen risk factors were scored during the workshop:

- The project cost/benefit may not be achieved due to change in cost which may impact other projects.
- Stakeholders may object to the project which may impose constraints on the project construction.
- Internal resources may not be available, which will increase the project cost and add to the schedule.
- Geotechnical conditions may not be favourable**.**
- Traffic issues may present challenges
- Hydraulic performance is uncertain impact surrounding sewer.
- The cost estimate may be inaccurate, resulting in cost overruns.
- Heated economy may drive cost up.
- Approvals and permits may delay the project and add cost.
- The footprint (and side slopes) are larger than anticipated which might create more significant environmental impact.
- Seasonality of the construction and the impact on the integrity of the surroundings (summer construction may encounter water from storms).
- If the project budget increases more than two milion, then the project may get cancelled.
- Encountering utilities in unexpected locations.
- Public may not accept the proposed option.
- Public safety during construction.
- The swale may increase highway noises to the houses in the area.
- Public safety during the operating life of the facility.
- Potential of encountering contaminated material.

Based on the quantitative assessment of the three proposed LY3 options, according to these eighteen risk factors, the workshop conclusions were that the surface overflow concept (Option 3) had less risk exposure and lower construction costs than the other two proposed options (see Sec. 2.4).

The complete results of this workshop have been summarized in a report prepared under a separate cover (S.M.A. Consulting 2006). A copy of this report is appended below.


Risk Assessment Report
Lynnwood LY3/L13
Ravine Inlet/Outlet
Controls Project
Workshop –Oct 11, 2006
Report –Nov. 07, 2006
S.M.A. Consulting Ltd.

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This report was prepared by S.M.A. Consulting Ltd. for the account of Earth Tech. The material in it reflects S.M.A.'s best judgment, in light of the information available to it, and the information provided to it by the client at the time of preparation.

Table of Content

1.0 Introduction

This report summarizes the results of the risk analysis carried out for *"Lynnwood LY3/L13 Ravine Inlet/Outlet Controls Project"* undertaken by the City of Edmonton. The designer is EarthTech.

Risk analysis and value analysis on this project commenced with a workshop on October 11, 2006. The workshop focused on understanding the project objectives, the deliverables, project value, risk and constructability. The following sections summarize the project concept and scope, the Structured Risk Analysis Process, and the results of the workshop. Participant in workshops are given in Appendix 1.

2.0 Project Overview

2.1 General Overview "Flood Prevention Program"1

Severe rainstorms in early July 2004 caused flooding on streets, roadways and in more than 4,000 homes throughout Edmonton. Damage to public and private property was extensive. This event prompted Drainage Services to make flood prevention a top priority. Drainage Services' flood prevention strategy has three key goals:

1. Find the main causes of flooding in at risk neighbourhoods,
2. Identify options for reducing the risk of flooding in the future, and
3. Work with communities and other stakeholders to implement viable solutions that improve flood prevention.

Figure 1 July 2004 Flood "Whitemud Drive"

[1] Resource City of Edmonton homepage

Based on flood reports, 62 neighbourhoods in Edmonton are considered at risk communities for future flooding. Among these, 15 neighbourhoods in 13 communities were considered high priorities because of the extent of flooding that occurred. These communities were:

1. Lakewood, Knottwood (includes neighbourhoods of Satoo, Menisa, Ekota) and North Millbourne (Ward 6)
2. Lendrum, McKernan, Parkallen, Malmo, Pleasantview (Ward 5)
3. Elmwood, Lynnwood, Rio Terrace, Quesnell Heights and Laurier Heights (Ward 1)

In February of 2005, engineering studies for high priority communities were completed. The studies included an in-depth analysis of what flooding occurred, looked at underground and surface issues, identified system weaknesses, and developed options for improving drainage in each community. Study results provide clarity as to what is needed to better flood prevention in neighbourhoods and homes. The results of the studies were shared with local residents at community consultation sessions that began on March 15, 2005. Each meeting:

1. Shared engineering findings for that specific community or communities,
2. Laid out various options,
3. Obtained residents' input, comments and opinions regarding the options.

Completion of all system upgrades will take several years. However, improvements that result in the greatest benefit for neighbourhoods will be done first and as soon as funding is available. Some prevention activities, such as plugging manhole covers and a public education program, have already begun.

As part of its flood prevention measures, Drainage Services is sponsoring a public education program to equip homeowners with the information and knowledge they need to make drainage improvements. The program launched in May 2005 includes: 1) home flood prevention check-up; 2) public information campaign; and 3) neighbourhood's education initiative.

Figure 2 West Edmonton Flood Study

Lynnwood LY3/L13 ravine is a part of the "West Edmonton Flood Study" which includes the communities of Elmwood, Lynnwood, Rio Terrace, Quesnell Heights, and Laurier Heights as shown in Figure 2. This project was identified as one of the highest priority projects to be constructed. The detailed design will be carried out by Earth Tech. Following is the project scope and deliverables.

2.2 Lynnwood Ravine Project

The Lynnwood Ravine is located north of Whitemud Drive and between 149th Street and 156th Street. The scope of this project is to help reduce the surcharge levels and street flooding between 156 Street and 159 Street along 83rd Avenue, and to reduce the basement flooding due to excessive sanitary inflows in upstream areas. The project concept recommended provides more controlled usage of the Lynnwood Ravine for stormwater management.

Figure 3 Lynnwood Ravine Location

Lynnwood Ravine Risk Analysis 3

To achieve the project scope, the following improvements were recommended for implementation:

- Increase the capacity of the Lynnwood Ravine outlet.
- Provide an overflow spillway from the Lynnwood Ravine to limit the high water level in the ravine.
- Increase the capacity of the storm mainline in the ravine.
- Construct a box structure to allow rapid water movement into the ravine.
- Increase the number of catch basins in the upstream area of 156th Street.

3.0 Risk Analysis Approach

S.M.A. Consulting utilizes a Structured Risk Analysis Process for projects. The process is described in this section.

3.1 Risk assessment using a standard set of risk factors and a checklist

S.M.A. Consulting has developed a checklist of standard risk factors for drainage projects at the concept level which was utilized in this study in the workshop was held on October 11, 2006.

The risk analysis team quantified the likelihood of occurrence and the magnitude of the impact of each of the identified factors. This was achieved using a standard set of tables as described in Section 2.2. Mitigation suggestions were then solicited to feed into the development of the risk management plan.

3.2 Quantifying risk factors

To quantify risk factors the following was used:

1. Determination of the likelihood of the factor being encountered (e.g. probability, or a subjective descriptor) using Table 1[2].
2. Determination of the magnitude of the impact if the factor is encountered (e.g. dollar value or a subjective descriptor) using Table 2 (in certain cases we may use supplementary tables as appropriate).
3. Determination of the overall severity of the factor by multiplying the likelihood (1) by magnitude (2).

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[2] Tables used in this report are copyright © 2001-2006, SMA Consulting. Use for purposes other than this study is not permitted without the written permission of SMA Consulting.

4. The factors are then grouped based on the overall severity score according to the grouping in Table 3.

In general, if the risk factors that scored in the "intolerable" range cannot be mitigated or a process for their mitigation foreseen, then the project owner should not proceed further with the project until a plan for mitigating the impacts of the factor can be defined and implemented. The remaining factors in the other zones can be accepted with a proper risk management plan established to secure reduction in their quantum.

Table 1. Assessment of likelihood/probability of risk occurrence

Descriptor	Explanation	Assigned Value
Highly Likely	Almost certain that it will happen, very frequent occurrence	100
Likely	more than 50-50 chance	50
Somewhat likely	less than 50-50 chance	25
Unlikely	small likelihood but could well happen	10
Very unlikely	not expected to happen	1
Extremely unlikely	just possible but would be very surprising	0.05

Table 2 Assessment of the magnitude of risk

Descriptor	Explanation	Assigned Value
Disastrous	The impact is totally unacceptable to the organization –value established in workshop or by owner.	700
Severe	Serious threat to the organization, public etc.	200
Substantial	Considerably affects cost	50
Moderate	Moderately effects costs	15
Marginal	Small effect on costs	5
Negligible	Trivial effect on costs	1

Table 3. Assessment of the consequence of a risk factor

Total severity	Category	Response
Over 10000	Intolerable	Must eliminate or transfer risk, it may jeopardize the entire organization or its cost may be manifold that of the project.
5001 - 10000	Critical	Expected cost to the project is unacceptably high. This risk must be eliminated or transferred before proceeding with the project. Attempt to avoid or transfer risk
1001 - 5000	Serious	Expected cost is high compared to total project cost. It probably is cost effective to eliminate or transfer this risk.
201 - 1000	Important	Consider eliminating or transferring. If accept then manage proactively.
26 - 200	Acceptable	Accept and manage
1 – 25	Negligible	The expected cost of this risk is too small to justify any mitigation effort. Accept and ignore it.

3.3 Risk Response

Once the identification and quantifications is completed, the Risk Analysis Team develops a response plan to all risk factors. This is described below:

a. Decide on the actions to be taken in response to key risks. Actions can include:
    i. Reduce uncertainty by obtaining more information. (This generally leads to a re-evaluation of the likelihood and sometimes the magnitude.)
    ii. Eliminate or avoid the risk factor through means such as partial or complete modifications to the proposed ideas, a different strategy or method etc.
    iii. Transfer the risk element to other parties.
    iv. Insure against the occurrence of the factor if and when possible.
    v. Abort the project if the risk is intolerable and no other means can be undertaken to mitigate its damages.
b. Plan response to key risks.
c. Communicate mitigating strategy and response plan to risk review team.

3.4 Risk Management

The risk management plan formalizes the risk response by defining specific tasks to be undertaken which will mitigate the risk, assigning responsibility and timelines for the tasks and following up on the risk factors on a regular basis until the project is complete.

4.0 Value Analysis Approach

S.M.A. Consulting employs Value Analysis to identify the best alternative among a set of different alternatives proposed to deliver the project. Value analysis is a proven management technique using a systematized approach to seek out the best functional balance between cost, reliability, and performance of the project.

4.1 Value Analysis Overview

Value Analysis is carried out as follow:

1. Complete a function analysis

2. Identify design alternatives.
3. List the advantages and disadvantages for each alternative and develop a good understanding of the difference between them.
4. Identify the comparison criteria, those criteria are usually defined by the project owner and represent what defines project success.
5. Find the quantitative weight for each criterion relative to the others, this can be done using the Analytical Hierarchy Process (AHP).
6. Score each of the alternatives for the comparison criteria and find the total score for each alternative.
7. Find the total cost of the alternative by adding the construction estimated cost and the expected cost of risk.
8. Find the alternatives values by dividing the total score by the total cost.
9. Select alternative with the highest value.

4.2 Evaluation Procedure

S.M.A. Consulting utilizes AHP to evaluate the weights of the evaluation criteria, Analytical Hierarchy Process (AHP) can be defined as a well established, mathematically proven formal method used for selecting the best alternative. AHP is superior over other pair wise comparison techniques in terms of accounting for consistency of thoughts.

The procedure for performing AHP as follow:

1- Define a set of evaluation criteria for that particular project
2- Perform pair wise comparison between those set of criteria, as shown in Table 4.
3- Calculate criteria relative weight
4- Evaluate criteria score of each alternative (out 100)

For the purpose of facilitating AHP comparison a computer program is used. The pair wise comparison of criteria is conducted as the name implies in pairs using the scale given in Table 4. After all pairs are analyzed, we calculate the criteria weight and the consistency ratio. The consistency ratio is used to identify if any logical errors took place during the pair-wise comparison.

Table 4 Importance Scale

Importance	Definition	Explanation
1	Equal Importance	Two criteria contribute equally to the objective
3	Weak importance of one over another	Experience and judgment slightly favour one criteria over another
5	Essential or strong importance	Experience and judgment strongly favour one criteria over another
7	Demonstrated importance	A criteria is strongly favoured and its dominance demonstrated in practice
9	Absolute importance	The evidence favouring one criteria over another is of the highest possible order of affirmation
1,4,6,8	Intermediate values between the two adjacent judgments	When compromise is needed

4.3 Alternatives Value

Value can be defined as the ratio between what we can get out of something over what we put into it. The higher the value the better the alternative. Value can be calculated as follow:

$$Value = \frac{\text{What we get out of something}}{\text{What we put into it}}$$, or

$$Value = \frac{\text{Quality, Reliability, Appeal, etc.}}{\text{Cost, Time, Mass, Energy, etc.}} = \frac{\text{Benefits}}{\text{Resources}}$$, or

$$Value = \frac{\text{Worth}}{\text{Cost}} = \frac{\text{Function}}{\text{Cost}}$$

5.0 Summary of results for this project

Based on the draft preliminary design report for the Lynnwood project, five major physical components can be identified:

1. Storm Trunk Extension
2. Overflow Structure
3. Outlet Structure
4. Emergency Overflow Swale
5. Upstream Upgrades (additional catch basins)

5.1 Construction Options

Strom Trunk Extension component represents about 80% of the project total construction cost. There are three options in which the function of this extension can be delivered as follows:

1. Extending the existing 1800 mm trunk 164m to the east. Replacement of portion of the pipe is required.
2. Twining the existing Trunk with 1350 mm pipe. (Option in the preliminary design report). . This option is to combine the outlet grating (of required design size) new manhole in the LY4 project. Since LY4 may be constructed after this project, as a temporary measure, the cover of the existing manhole, immediate east the existing 200 mm outlet, will be replaced by a grated cover (catch basin style).
3. Storm Sewer Extension: Option 3 is to upgrade approx. 42 m of storm trunk from 1200 mm to 1800 mm pipe (to the east), and to reshape the bottom of the Ravine for some 140m (0-1.5 m deep). The box overflow structure will be built at the end of upgraded 1800 mm pipe. The bottom of the reshaped ravine will be 3 m wide with 4:1 side slopes to existing ravine (which some localize 3:1 slopes). The hydraulic performance and estimated construction cost of option 3 was compared to the other two options (which were discussed in draft preliminary design report). This option is shown in Figure 4.

Figure 4 Storm Sewer Extensions (Option 3)

In order to evaluate the merits of each of the options, value analysis was carried out.

5.2 Project Risk Analysis

The project risk factors were identified and quantified by the project team using the method described in Section 3. 18 risk factors were identified as shown below:

1. The project cost/benefit may not be achieved due to change in cost which may impact other projects
2. Stakeholders may object to the project which may impose constraints on the project construction
3. Internal resources may not be available, which will increase the project cost and add to the schedule
4. Geotechnical conditions may not be favorable.
5. Traffic issues may present challenges
6. Performance (Hydraulic) is uncertain impacting surrounding sewer
7. The estimate may be inaccurate resulting in cost overruns
8. Heated economy may drive the cost up
9. Approvals and permits may delay the project and add cost
10. The foot print (and side slopes) is larger than anticipated which might create more significant environmental impact
11. Seasonality of the construction and the impact on the integrity of surrounding (summer construction may encounter water from storms)
12. If the project budget increases more than 2 million then the project may get canceled
13. Encountering utilities in unexpected locations
14. Public may not accept the proposed option
15. Public safety during construction
16. The Swale may increase the highway noise to the houses in the area
17. Public safety during the operating life of the facility
18. Potential of encountering contaminated material

Those risk factors were quantified for each of the remaining two options and the expected cost of risk was evaluated based on the quantification. The detailed results are given in Appendix 2.

5.3 Value Analysis

For the three options value analysis was conducted in conjunction with the Risk analysis to select the best construction alternative.

5.3.1 Criteria Evaluation

Six criteria were defined by the analysis team as a means of evaluating the three options. We first defined the criteria and their relative weights using the Analytical Hierarchy Process (AHP) as shown in Table 5.

Table 5 Selection Criteria

#	Criterion	Weight
1	Environmental impact	0.27
2	Technical (HGL & flooding)	0.43
3	Constructability	0.10
4	Operation	0.03
5	Maintenance	0.04
6	Public	0.14

The three options are summarized for convenience as follows:

1. Replacing and extending the pipe.
2. Twining
3. Surface Overflow with minimum replacement and extension

For each of the above options each criterion was considered and a score given to the option as shown in Table 6.

Table 6 Strom Trunk Extension Component Option Evaluation

		Option 1 Upgrade 164 m		Option 2 Twining		Option 3 Short Upgrade (42 m)	
Item	Weight	Rating (100)	Score	Rating (100)	Score	Rating (100)	Score
1. Environmental impact	0.27	80	21.7	60	16.3	80	21.7
2. Technical (HGL & flooding)	0.43	80	34.1	80	34.1	80	34.1
3. Constructability	0.10	70	6.7	40	3.8	80	7.6
4. Operation	0.03	80	2.1	80	2.1	80	2.1
5. Maintenance	0.04	90	3.6	70	2.8	60	2.4
6. Public	0.14	80	11.3	80	11.3	80	11.3
Total Score			79.4		70.4		79.2

Table 7 Risk Analysis Evaluation Summary

Severity Level	Replacement	Surface Overflow
Negligible	1	2
Acceptable	7	5
Important	5	9
Serious	5	2
Total Severity Score	11740	8255
Expected Cost of Risk (Thousands)	112	77

A quick evaluation of the results in Tables 6 and 7 shows that Option 2 can be dropped from further analysis. The other two options were carried for further evaluation.

5.3.2 Options Value

The option value is evaluated by dividing the total score by the cost (including cost of risk), which is a combined measure for the highest benefit for dollar spent. The results for Options 1, 3 are given in Table 8.

Table 8 Options Value Analysis

		Replacement		Twining		Surface Overflow	
Item	Weight	Rating (100)	Score	Rating (100)	Score	Rating (100)	Score
1. Environmental impact	0.27	80	21.7	60	16.3	80	21.7
2. Technical (HGL & flooding)	0.43	80	34.1	80	34.1	80	34.1
3. Constructability	0.10	70	6.7	40	3.8	80	7.6
4. Operation	0.03	80	2.1	80	2.1	80	2.1
5. Maintenance	0.04	90	3.6	70	2.8	60	2.4
6. Public	0.14	80	11.3	80	11.3	80	11.3
Total Score			79.4		70.4		79.2
		Cost of Risk	112				77
		Estimate	700				500
		Total Cost	812				577
		Value	98				137

6.0 Conclusions

The risk and value analysis suggested the adoption of the surface overflow option (option 3) over the original design concept of extending the 1800mm line. The surface overflow concept has less risk exposure and cheaper construction cost with same value in most respects (based on criteria established).

Furthermore, this currently preferred option has two serious risk factors which will need to be mitigated prior to adopting it. Those risk factors are:

1. The foot print (and side slopes) is larger than anticipated which might create more significant environmental impact than currently assumed.
2. Internal resources may not be available, which will increase the project cost and add to the schedule.

Appendix 1. –Participants in the Risk Analysis

Name	Company
Leonora Lumabi	City of Edmonton- Drainage Design and Construction
Ken Chua	City of Edmonton- Drainage Design and Construction
Douwe Vanderwel	City of Edmonton- Drainage Planning
Doug Eastwell	City of Edmonton- Drainage Design and Construction
Ed Egyedy	City of Edmonton- Environmental Planning
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George Gortva	City of Edmonton- Transportation Planning
Will Wawrychuk	Earth Tech
Bob Boon	Earth Tech
Greg Farion	Earth Tech
Michelle Yu	Earth Tech
Magdy Hashem	Earth Tech
Richard Spencer	Spencer Environmental
David Yue	Sameng

Appendix 2. –Risk Factors October 11, 2006

Appendix #2: Risk Factors

S.M.A. Consulting Ltd.

Number	Risk Factor	Option1: Replacement				112	Option3: 3. Surface Overflow				77
		Likely.	Magn.	Severity		Expec. cost	Likely.	Magn.	Severity		Expec. cost
1	The project cost/benefit may not be achieved due to change in cost which may impact other projects	U	SUB	500	Important	0.004	VU	SUB	50	Acceptable	0.000
2	stakeholders may object to the project which may impose constraints on the project construction	U	MOD	150	Acceptable	0.001	SL	MOD	375	Important	0.004
3	Internal resources may not be available, which will increase the project cost and add to the schedule	L	SUB	2500	Serious	0.026	SL	SUB	1250	Serious	0.013
4	geotechnical conditions may not be favorable	SL	SUB	1250	Serious	0.013	SL	MAR	125	Acceptable	0.001
5	Traffic issues may present challenges	L	MOD	750	Important	0.008	SL	MOD	375	Important	0.004
6	Performance (Hydraulic) is uncertain impacting surrounding sewer	U	MOD	150	Acceptable	0.001	U	MOD	150	Acceptable	0.001
7	the estimate may be inaccurate resulting in cost overruns	U	MOD	150	Acceptable	0.001	L	MOD	750	Important	0.008
8	heated economy may drive the cost up.	L	MOD	750	Important	0.008	L	MAR	250	Important	0.003
9	approvals and permits may delay the project and add cost	L	MAR	250	Important	0.003	HL	MAR	500	Important	0.004
10	The foot print (and side slopes) is larger than anticipated which might create more significant Environmental impact	SL	MOD	375	Important	0.004	L	SUB	2500	Serious	0.026
11	Seasonality of the construction and the impact on the integrity of surrounding (summer construction may encounter water from storms)	SL	SUB	1250	Serious	0.013	U	SUB	500	Important	0.004
12	If the project budget increases more than 2 million then the project may get canceled	U	SEV	2000	Serious	0.016	VU	SEV	200	Important	0.001
13	Encountering utilities in unexpected locations	VU	MOD	15	Negligible	0.000	VU	MOD	15	Negligible	0.000
14	Public may not accept the proposed option	VU	SUB	50	Acceptable	0.000	U	SUB	500	Important	0.004
15	Public safety during construction	SL	SUB	1250	Serious	0.013	U	SUB	500	Important	0.004
16	The Swale may increase the highway noise to the houses in the area	VU	SUB	50	Acceptable	0.000	VU	SUB	50	Acceptable	0.000
17	Public safety during the operating life of the facility	U	MOD	150	Acceptable	0.001	U	MOD	150	Acceptable	0.001
18	Potential of encountering contaminated material	U	MOD	150	Acceptable	0.001	VU	MOD	15	Negligible	0.000

Appendix C. Constructability and Risk Assessment Workshop for the LY4 Project

Value Item	*Weight*
Environmental	17
Cost Overrun	6
Constructability	6
Operations and Maintenance	10
Safety	20
Public Acceptance	17
Life of Works	4
Compatibility with Sanitary Sewer	15
Schedule	5
Total	**100**

A description of each of the value items was subsequently developed and is included below:

Environmental:	This addresses any concerns related to potential detrimental effects to the environment.
Cost Overrun:	This relates to the likelihood and/or anticipated magnitude of a cost overrun.
Constructability:	This relates to the ease with which each alternative can be constructed.
Operations and Maintenance:	This relates to the ease with which an alternative can be operated and maintained.
Safety:	This addresses the safety of the public at large during or after construction.
Public Acceptance:	This relates to the expected level of acceptance from affected residents, user groups and the public at large.
Life of Works:	This addresses the anticipated life of any proposed works and of the modified system.
Compatibility with Sanitary Sewer:	This includes any opportunities for both the storm and sanitary works to be carried out synergistically.
Schedule:	This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.

Using the value items and their respective weights, value scoring sheets (Appendix B) were developed and participants were asked to rate each of the design alternatives on a scale of 1 to 5 (described below) with one being unacceptable and 5 being ideal:

1 = unacceptable, the alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.

2 = significant impact, the alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.

3 = some impact, the alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.

4 = minimal impact, the alternative is a favourable option with only minimal concern or impacts with respect to the value item.

5 = ideal, the alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.

Both the LY4 trunk sewer upgrade and the 84th Avenue ponding relief solutions were scored in this manner. Table 3.2 and Table 3.3 represent a summary of the scoring results. The detailed scoring sheets are included under Appendix B. Table 3.2 demonstrates that trenchless installation of the 1050 mm sewer scored the highest for the trunk sewer upgrade. Catchbasin improvements were also considered as a potential relief solution at 84th Avenue. However, since this does not provide sufficient flood protection by itself, an aggregate score is presented in Table 3.3 which includes catchbasin improvements in addition to each of the described upgrades.

Trunk Upgrade Option 1: Replacement

Risks:

- Care of water
- Potential damages to infrastructure
- Impacts to park/ravine (downstream portion would be open cut through ravine)
- Cost overruns related to potential residential damage (service connections)
- Risk for delay
- Temporary servicing during construction (storm/sanitary)
- Relative accuracy of cost estimates
- *Air entrapment*
- *Hail effect*
- *Increased truck traffic/damage to nearby roads*
- *Late season risks (costs/paving/availability of materials)*

} *Common to all alternatives*

Constructability:

- Disturbance to residents
- Permits
- Limited construction space: a custom cage would likely be needed (increased cost)
- Higher backfill costs
- As-built unknowns (2 months may not be enough construction time)
- Environmental impact (sediment)
- Possible conflicts with other utilities
- Traffic impacts
- Safety to residents (requires 6 m trench in front of residences)
- Public opposition

Operability:

- Sewer is easier to maintain when located in the roadway

Value Engineering:

- Medium cost option, but with greatest risk for cost overrun
- *Construction costs rising*

} *Common to all alternatives*

City of Edmonton – Lynnwood LY4 Storm Trunk Upgrading
Sameng Inc.

Trunk Upgrade Option 2: Twinning (Open Cut)

Risks:

- Safety
- Impacts to ravine/park
- Delay in permitting (currently only approved for replacement option)
- Public acceptance
- Environmental perception
- High level of disturbance
- Inundation of park areas with utilities

Constructability:

- Trench stability
- Road reconstruction costs (pipe jacking could be employed however)
- Conflict with sanitary sewer

Operability:

- Infrastructure in ravine is more complicated to access/maintain
- Higher risk of long term failure in ravine

Value Engineering:

- Lowest cost option

Trunk Upgrade Option 3: Twinning (Trenchless)

Risks:
- Public perception
- Environmental perception
- Impacts to park/ravine
- Delay in permitting (currently only approved for replacement option)
- Potential conflict with future sanitary sewer
- Frac-out possibilities (rescue shaft may be required)
- Inundation of park areas with utilities

Constructability:
- Resource availability
- Risk to ravine

Operability:
- Infrastructure in ravine is more complicated to access/maintain
- Higher risk of long term failure in ravine

Value Engineering:
- Most expensive
- Greater acceptance by transportation
- Potential to synergize with proposed sanitary sewer

City of Edmonton – Lynnwood LY4 Storm Trunk Upgrading
Sameng Inc.

Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: LEONORA LUMABI

Title: _____

	Value Items	Assigned Weight	Replace Existing Pipe	Twin with Open Cut	Twin via Trenchless
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	2	3	5
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	1	2	4
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	2	3	5
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	5	4	4
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	1	5	5
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	3	2	5
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	2	4	5
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	2	3	5
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	5	3	2
	Total	100	47.2	66.2	93.8

Rating Description

1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: Will Wawrychuk

Title: Earth Tech Project Manager, Lynnwood LY3/L13

	Value Items	Assigned Weight	Replace Existing Pipe	Twin with Open Cut	Twin via Trenchless
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	5	1	3
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	2	4	3
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	2	5	4
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	3	3	3
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	2	3	4
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	4	1	3
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	5	3	3
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	4	2	3
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	4	2	2
	Total	100	69.4	46	64.2

Rating Description

1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: Ken Chua

Title: Program Manager

	Value Items	Assigned Weight	Replace Existing Pipe	Twin with Open Cut	Twin via Trenchless
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	3	2	4
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	3	3	3
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	3	4	3
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	4	4	4
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	4	4	4
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	3	3	4
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	5	4	5
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	4	2	3
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	5	3	3
	Total	100	72.6	61.6	74.4

	Rating Description
1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: Jason Meliefste

Title: General Supervisor - Roadways Design

	Value Items	Assigned Weight	Replace Existing Pipe	Twin with Open Cut	Twin via Trenchless
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	3	1	5
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	2	3	2
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	3	2	2
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	4	2	3
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	2	3	4
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	2	1	5
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	5	2	3
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	4	3	2
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	2	2	3
	Total	100	57	41.4	72.2

Rating Description

1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal Impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: Douwe Vanderwel

Title: Senior Engineer, Strategic Planning. Edmonton

	Value Items	Assigned Weight	Replace Existing Pipe	Twin with Open Cut	Twin via Trenchless
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	3	2	3
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	2	2	3
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	2	3	4
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	3	4	4
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	2	2	4
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	2	2	2
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	4	2	2
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	4	3	3
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	3	3	3
	Total	100	54	49.2	63

Rating Description

1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: Doug Eastwell

Title: Senior Cost Estimator

	Value Items	Assigned Weight	Replace Existing Pipe	Twin with Open Cut	Twin via Trenchless
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	3	2	4
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	2	3	3
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	1	3	4
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	3	3	4
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	2	3	4
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	2	2	4
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	4	3	3
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	2	2	4
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	2	2	2
	Total	100	45.8	49.2	76

Rating Description

1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
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5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: Albert Kwan

Title: _____

	Value Items	Assigned Weight	Replace Existing Pipe	Twin with Open Cut	Twin via Trenchless
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	2	4	5
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	3	3	2
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	3	4	4
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	4	4	4
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	4	4	4
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	4	4	4
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8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	4	4	4
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	3	4	2
	Total	100	69	78	78.2

Rating Description

1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
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5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: Tony Ruban

Title: Geotechnical Consultant, EBA

	Value Items	Assigned Weight	Replace Existing Pipe	Twin with Open Cut	Twin via Trenchless
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	3	2	5
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	2	4	4
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	2	5	5
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	5	5	4
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	2	3	4
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8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	4	4	5
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	5	3	4
	Total	100	64.2	68.8	91.8

Rating Description

1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal Impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: Gerry Samide

Title: Facilitator

	Value Items	Assigned Weight	Replace Existing Pipe	Twin with Open Cut	Twin via Trenchless
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	2	3	4
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	2	2	4
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	1	3	4
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	3	3	3
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	2	2	4
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	1	2	5
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	4	4	4
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	2	3	4
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	2	3	4
	Total	100	39	52.2	81.4

Rating Description

1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: David Yue

Title: Project Manager, Sameng Inc.

	Value Items	Assigned Weight	Replace Existing Pipe	Twin with Open Cut	Twin via Trenchless
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	4	3	5
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	2	3	4
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	1	3	4
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	4	2	3
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	2	3	5
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	1	3	5
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	5	4	4
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	4	3	5
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	2	2	5
	Total	100	54.6	57.8	92.8

Rating Description

1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
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5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: Dave Martz

Title: Design Team, Sameng Inc.

	Value Items	Assigned Weight	Replace Existing Pipe	Twin with Open Cut	Twin via Trenchless
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	4	1	4
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	2	3	4
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	2	4	3
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	4	4	3
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	3	4	3
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	2	4	4
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	5	3	3
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	4	4	3
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	4	1	2
	Total	100	65.2	64.8	67

Rating Description

1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal Impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: Kristel Pelletier

Title: Design Team, Sameng Inc.

	Value Items	Assigned Weight	Replace Existing Pipe	Twin with Open Cut	Twin via Trenchless
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	4	2	4
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	2	3	4
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	1	4	4
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	4	3	3
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	2	3	4
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	2	3	4
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	5	4	4
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	4	3	5
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	2	3	3
	Total	100	58	58.6	80

Rating Description

1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: Albert Yushko

Title: Project Engineer, Sameng Inc.

	Value Items	Assigned Weight	Replace Existing Pipe	Twin with Open Cut	Twin via Trenchless
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	4	1	4
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	2	3	2
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	1	4	3
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	4	2	3
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	1	3	4
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	3	3	5
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	5	4	4
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	5	2	4
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	2	5	4
	Total	100	60.4	52.2	77.8

Rating Description

1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: LEONORA LUMABI

Title: _____

	Value Items	Assigned Weight	Catchbasin Improvement Only	Sewer Extension (Trenchless Twinning)	Sewer Extension (Open Cut Replacement)	Surface Grading
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	5	5	5	5
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	3	3	2	3
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	5	4	2	3
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	4	5	3	3
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	4	5	4	4
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	5	5	4	4
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	2	5	5	5
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	3	1	3	5
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	4	1	2	5
	Total	100	82.2	80.4	72.4	83.8

	Rating Description
1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal Impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: Will Wawrychuk

Title: Earth Tech Project Manager, Lynnwood LY3/L13

	Value Items	Assigned Weight	Catchbasin Improvement Only	Sewer Extension (Trenchless Twinning)	Sewer Extension (Open Cut Replacement)	Surface Grading
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	5	3	2	1
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	4	3	3	3
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	5	3	2	5
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	4	4	4	2
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	3	4	2	2
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	5	4	2	1
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	4	2	4	3
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	4	4	2	4
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	4	4	2	3
	Total	100	84	72.6	46.8	45.8

Rating Description

1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal Impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: Ken Chua

Title: Program Manager

	Value Items	Assigned Weight	Catchbasin Improvement Only	Sewer Extension (Trenchless Twinning)	Sewer Extension (Open Cut Replacement)	Surface Grading
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	5	4	3	3
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	5	3	4	4
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	5	4	4	3
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	5	3	3	3
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	5	4	4	4
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	5	4	3	4
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	5	4	5	4
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	5	2	2	5
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	5	4	4	4
	Total	100	100	70.8	66	76.4

	Rating Description
1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal Impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: Jason Meliefste

Title: General Supervisor - Roadways Design

	Value Items	Assigned Weight	Catchbasin Improvement Only	Sewer Extension (Trenchless Twinning)	Sewer Extension (Open Cut Replacement)	Surface Grading
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	5	5	2	2
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	5	3	3	3
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	5	2	3	4
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	4	3	3	2
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	3	3	2	2
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	2	4	4	3
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	3	3	3	2
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	2	2	4	2
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	4	4	3	2
	Total	100	68.2	67	59	47

	Rating Description
1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal Impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: Douwe Vanderwel

Title: Senior Engineer, Strategic Planning, Edmonton

	Value Items	Assigned Weight	Catchbasin Improvement Only	Sewer Extension (Trenchless Twinning)	Sewer Extension (Open Cut Replacement)	Surface Grading
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	3	3	3	3
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	3	3	2	2
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	3	2	1	2
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	3	3	3	1
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	3	3	2	2
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	3	4	1	1
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	3	3	3	2
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	3	4	4	4
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	3	3	2	2
	Total	100	60	65.2	47.6	44

Rating Description

1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal Impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: Doug Eastwell

Title: Senior Cost Estimator

	Value Items	Assigned Weight	Catchbasin Improvement Only	Sewer Extension (Trenchless Twinning)	Sewer Extension (Open Cut Replacement)	Surface Grading
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	4	4	3	2
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	5	2	2	4
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	5	2	2	3
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	4	3	3	2
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	4	4	1	2
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	5	5	2	2
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	4	4	4	3
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	2	2	2	2
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	4	2	2	3
	Total	100	79.8	68.6	43	45.4

Rating Description

1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: Albert Kwan

Title: _____

	Value Items	Assigned Weight	Catchbasin Improvement Only	Sewer Extension (Trenchless Twinning)	Sewer Extension (Open Cut Replacement)	Surface Grading
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	5	2	1	3
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	5	2	2	3
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	5	3	2	2
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	4	4	4	3
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	5	5	5	5
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	4	4	4	4
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	3	3	3	2
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	5	3	3	3
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	5	3	3	4
	Total	100	93	68.8	64.2	70.4

	Rating Description
1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: Tony Ruban

Title: Geotechnical Consultant, EBA

	Value Items	Assigned Weight	Catchbasin Improvement Only	Sewer Extension (Trenchless Twinning)	Sewer Extension (Open Cut Replacement)	Surface Grading
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	4	5	2	3
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	4	5	3	5
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	4	4	2	4
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	5	4	5	5
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	4	4	2	4
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	5	5	4	3
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	5	5	5	5
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	5	3	4	5
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	4	4	4	4
	Total	100	89.2	85.8	64.4	80.2

	Rating Description
1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal Impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: Gerry Samide

Title: Facilitator

	Value Items	Assigned Weight	Catchbasin Improvement Only	Sewer Extension (Trenchless Twinning)	Sewer Extension (Open Cut Replacement)	Surface Grading
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	4	4	3	3
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	4	4	2	3
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	4	4	3	3
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	4	4	4	3
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	3	4	2	2
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	4	5	3	3
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	4	4	4	4
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	5	4	3	4
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	4	4	3	3
	Total	100	79	83.4	57.6	59.8

Rating Description

1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal Impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: David Yue

Title: Project Manager, Sameng Inc.

	Value Items	Assigned Weight	Catchbasin Improvement Only	Sewer Extension (Trenchless Twinning)	Sewer Extension (Open Cut Replacement)	Surface Grading
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	5	5	5	5
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	5	3	2	5
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	5	3	1	5
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	5	5	5	2
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	5	5	2	5
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	5	4	2	3
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	4	5	5	3
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	5	3	4	5
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	5	4	2	3
	Total	100	99.2	84.8	63.4	83.6

Rating Description

1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: Dave Martz

Title: Design Team, Sameng Inc.

	Value Items	Assigned Weight	Catchbasin Improvement Only	Sewer Extension (Trenchless Twinning)	Sewer Extension (Open Cut Replacement)	Surface Grading
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	5	3	2	3
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	5	2	2	3
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	5	2	3	4
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	5	3	3	1
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	5	3	3	4
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	1	5	2	3
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	3	3	3	2
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	5	3	3	3
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	5	4	4	4
	Total	100	84.8	65.4	53	61.4

Rating Description

1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal Impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: Kristel Pelletier

Title: _____

	Value Items	Assigned Weight	Catchbasin Improvement Only	Sewer Extension (Trenchless Twinning)	Sewer Extension (Open Cut Replacement)	Surface Grading
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	5	4	3	5
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	5	3	2	4
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	5	3	2	5
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	5	3	3	2
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	4	4	2	5
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	3	2	1	2
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	5	5	5	3
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	5	3	3	5
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	5	4	4	4
	Total	100	89.2	66.6	49.4	80

	Rating Description
1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal Impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Lynnwood LY4 Storm Trunk Upgrade

Project Risk and Value Assessment Workshop

Name: Albert Yushko

Title: Project Engineer, Sameng Inc.

	Value Items	Assigned Weight	Catchbasin Improvement Only	Sewer Extension (Trenchless Twinning)	Sewer Extension (Open Cut Replacement)	Surface Grading
1	**Environmental** *This addresses any concerns related to potential detrimental effects to the environment.*	17	5	5	5	3
2	**Cost Overrun** *This relates to the likelihood and/or anticipated magnitude of a cost overrun.*	6	5	4	4	4
3	**Constructability** *This relates to the ease with which each alternative can be constructed.*	6	5	3	4	5
4	**Operations and Maintenance** *This relates to the ease with which an alternative can be operated and maintained.*	10	5	4	4	2
5	**Safety** *This addresses the safety of the public at large during or after construction.*	20	4	3	2	4
6	**Public Acceptance** *This relates to the expected level of acceptance from affected residents, user groups and the public at large.*	17	5	1	2	3
7	**Life of Works** *This addresses the anticipated life of any proposed works and of the modified system.*	4	5	5	5	3
8	**Compatibility with Sanitary Sewer** *This includes any opportunities for both the storm and sanitary works to be carried out synergistically.*	15	5	2	4	5
9	**Schedule** *This addresses the likelihood and/or severity of any potential scheduling delays as a result of permitting, funding, public support or construction issues.*	5	5	3	4	5
	Total	100	96	61.8	69.4	73.6

	Rating Description
1	Unacceptable *The alternative is clearly inferior with respect to the value item and there are significant concerns and/or impacts which could not be mitigated.*
2	Significant Impact *The alternative is an unfavourable option. There are significant concerns and/or impacts with respect to the value item which cannot easily be mitigated.*
3	Some Impact *The alternative is a neutral option. While there are valid concerns and/or impacts related to the value item, these are not prohibitive and/or can be mitigated.*
4	Minimal Impact *The alternative is a favourable option with only minimal concern or impacts with respect to the value item.*
5	Ideal *The alternative is clearly a superior choice and there are essentially no concerns or impacts with respect to the value item.*

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Appendix D. Open House Summary

Forty-eight people attended the open house which was held at the Lynnwood Community Hall on the evening of November 9, 2006. There were very few concerns expressed about the potential environmental effects of the proposed LY3 and LY4 projects.

The following two questions concerning the environment of the Lynnwood Ravine were included on the questionnaire used at the open house:

Question 1
In order to comply with the provisions of the North Saskatchewan River Valley Area Redevelopment Plan (Bylaw 7188) an Environmental Screening Report of the project is being completed. Do you have any information regarding the fauna, flora or environment in or around the Lynnwood Ravine which you feel is important for us to know?

Question 2
Do you have any concerns regarding the impact of the project on the environment of the Lynnwood Ravine or adjacent residential area?

The written concerns of the public in response to Question 1 were:

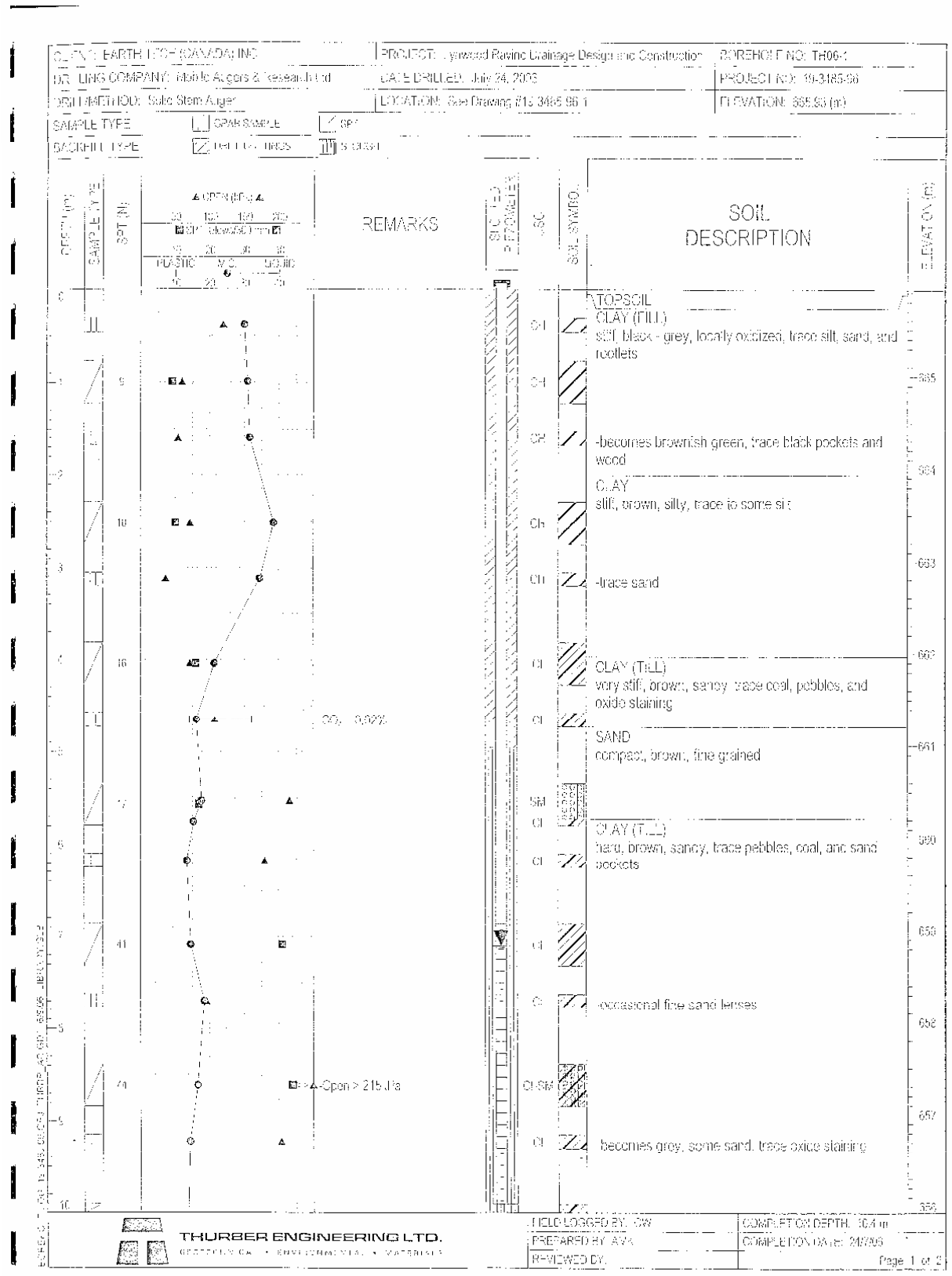
- No.
- Try to save (do not cut down) the dead standing trees. Cavity nesting birds may use them and they may be a source of insects.
- Yes.
- Construct a fence barrier at west entrance to keep vehicles out of ravine.
- No.

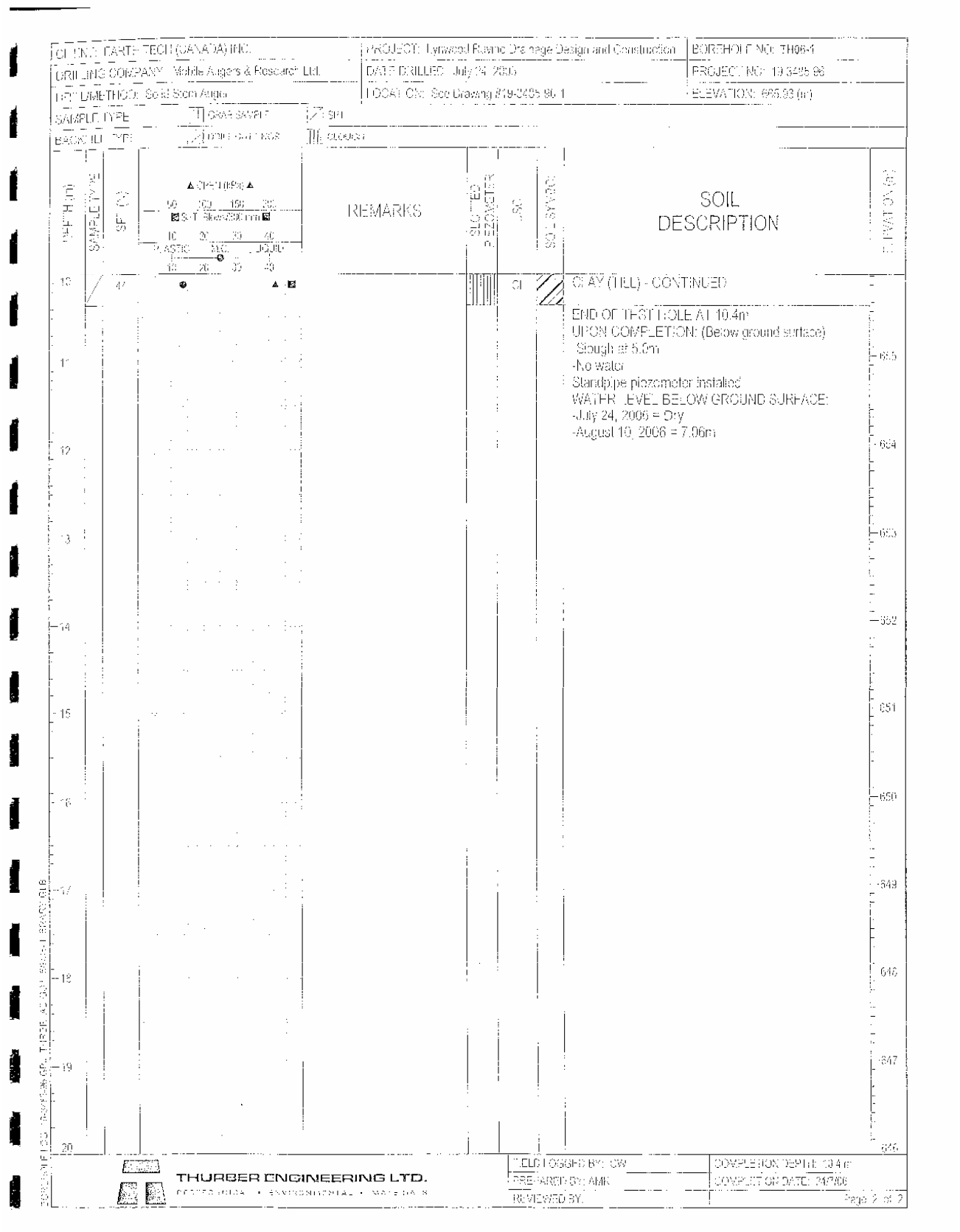
The written concerns of the public in response to Question 2 were:

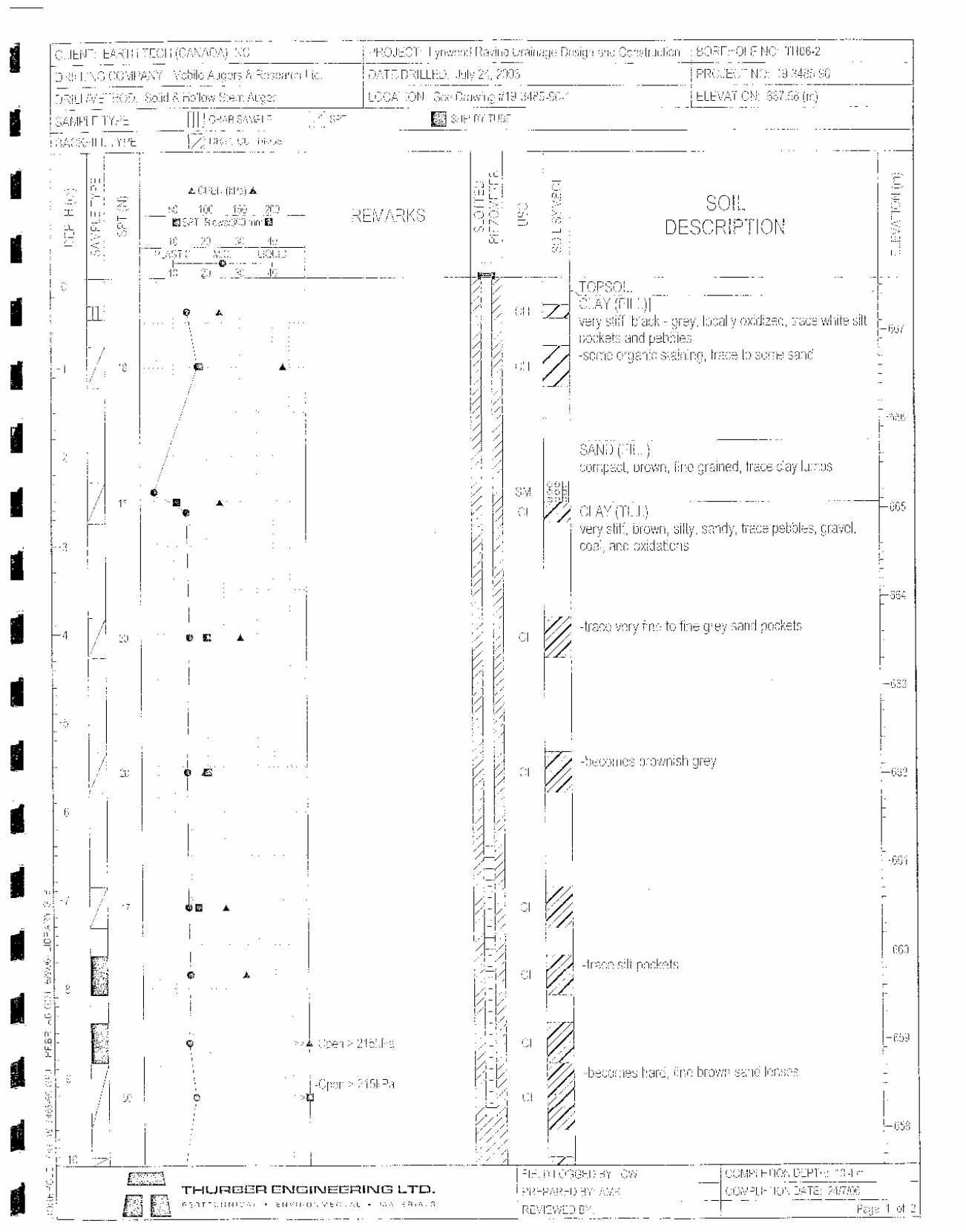
- Yes. My property is adjacent to the ravine. I sincerely hope that it will remain a natural setting.
- No.
- Yes. Just the disruption of a beautiful, integral part of our community.
- Keep biodiversity as high as possible. Don't plant just one or two varieties of trees and shrubs.
- Yes.
- Environmental impact seems minimal.
- No.

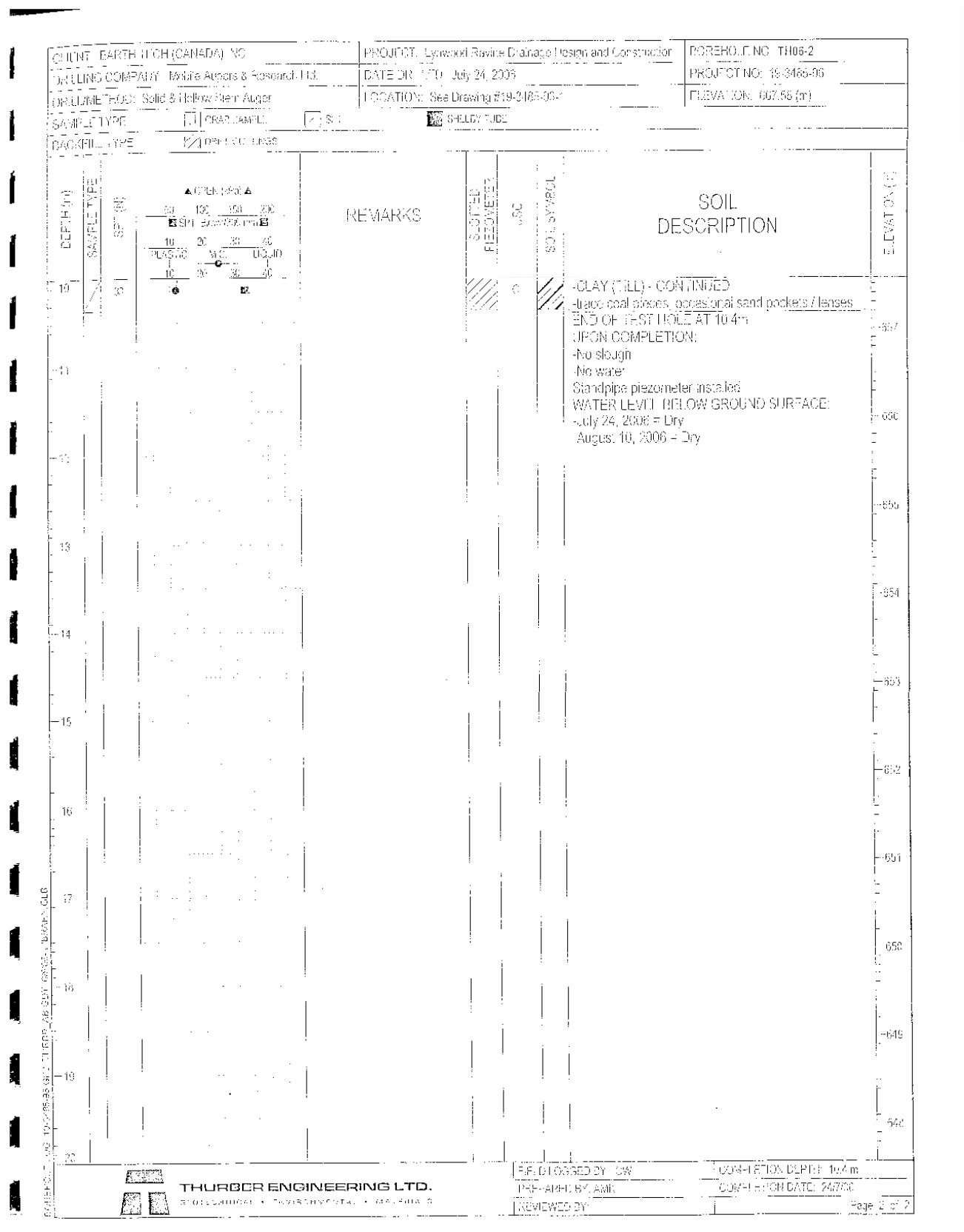
Appendix E. Geotechnical Borehole Logs for the LY3 Project (Main Ravine)

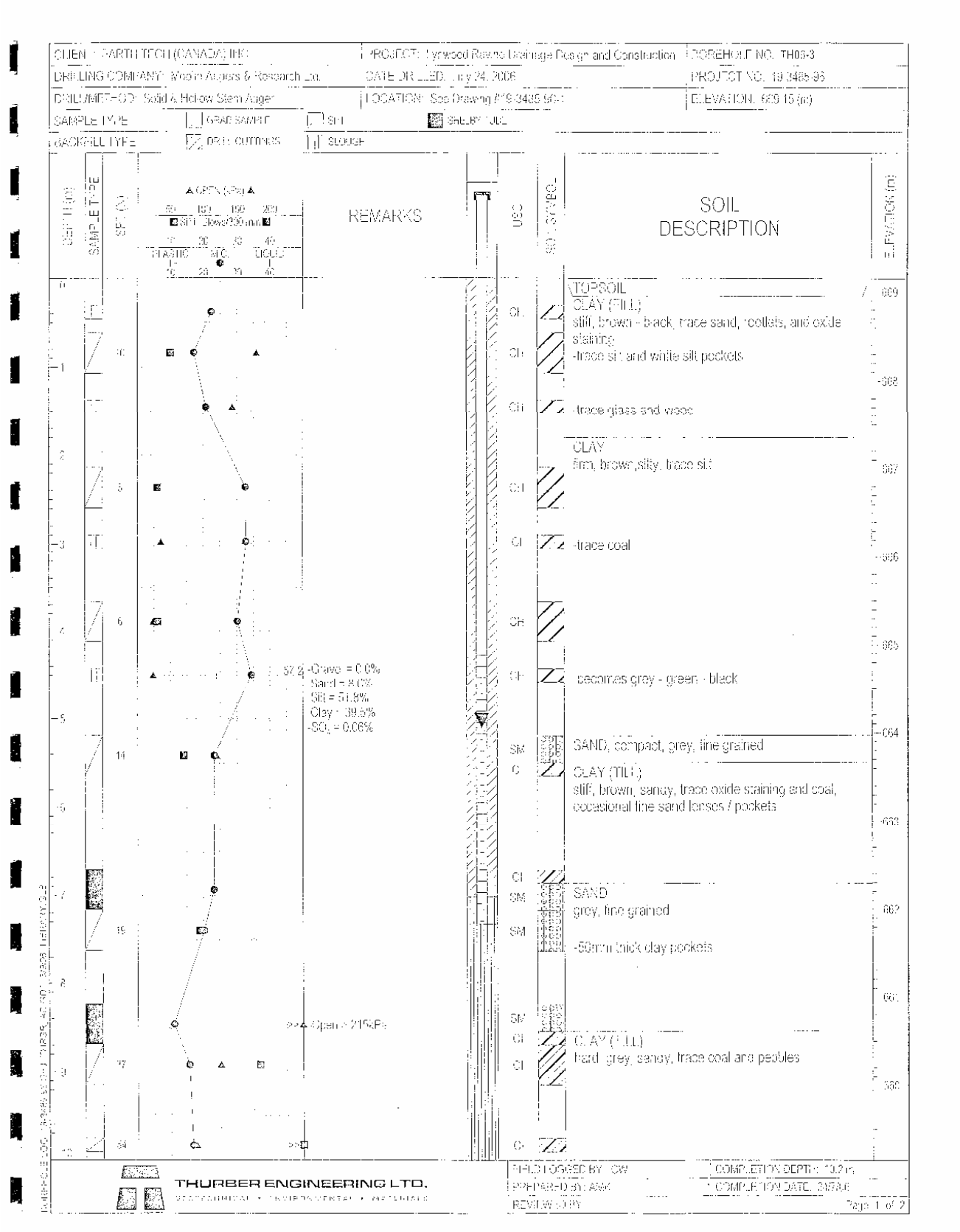
These borehole logs contain detailed information about the soils and groundwater of the LY3 ravine. The boreholes were drilled by Thurber Engineering on July 24, 2006, at three locations in the centre of the ravine (see Figure 1.3).

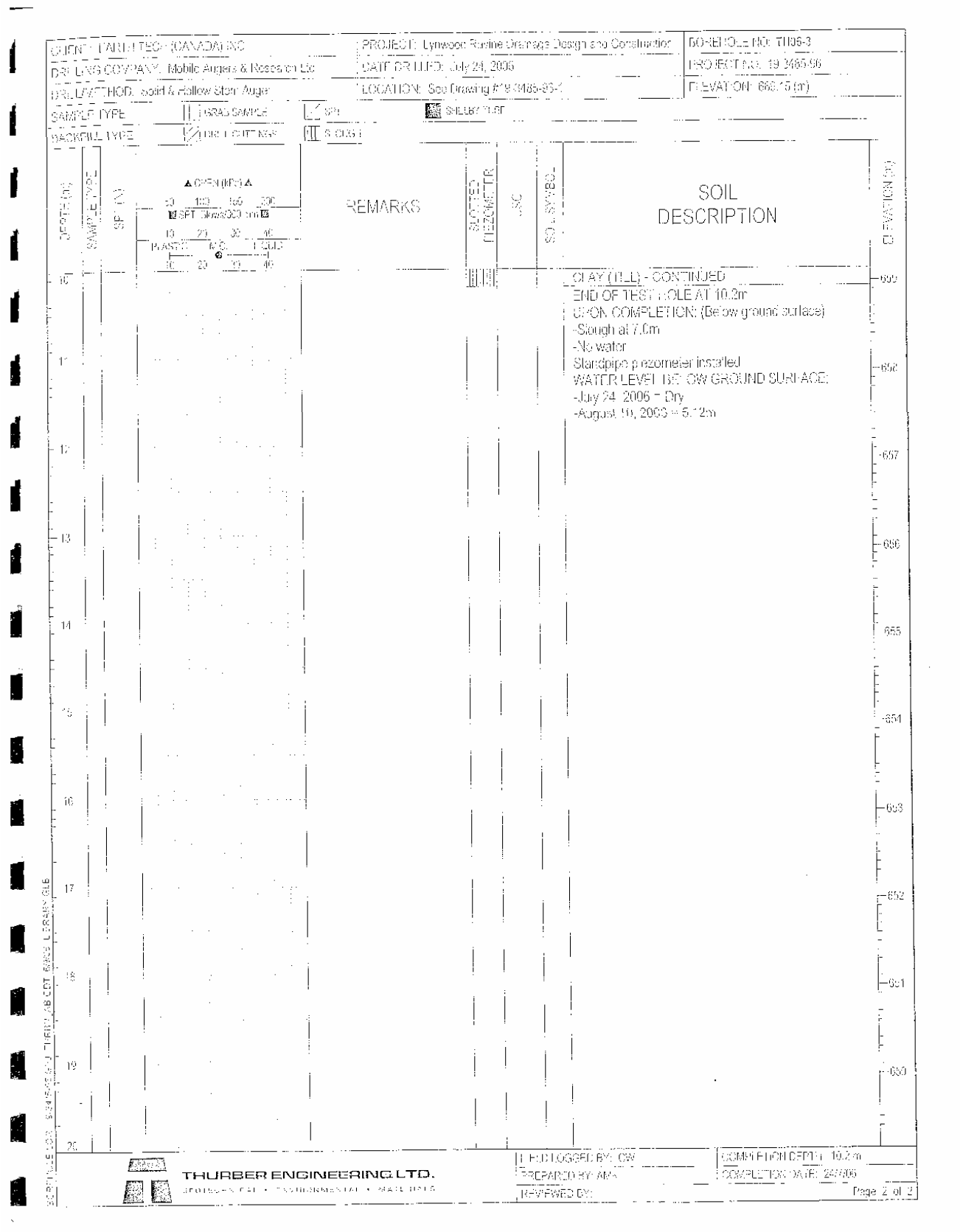

CLIENT: EARTH TECH (CANADA) INC.
PROJECT: Lynnwood Ravine Drainage Design and Construction
BOREHOLE NO: TH06-1
DRILLING COMPANY: Mobile Augers & Research Ltd.
DATE DRILLED: July 24, 2006
PROJECT NO: 19-3185-06
DRILLING METHOD: Solid Stem Auger
LOCATION: See Drawing #19-3185-06-1
ELEVATION: 665.93 (m)
SAMPLE TYPE
SPLIT SPOON SAMPLE
GRAB
BACKFILL TYPE
BENTONITE CHIPS
SAND BACKFILL
DEPTH (m)
SAMPLE TYPE
SPT (N)
OPEN (kPa)
PLASTIC
W
LIQUID
REMARKS
STICK UP OR PIEZOMETER
SOIL SYMBOL
SOIL DESCRIPTION
ELEVATION (m)
TOPSOIL
CLAY (FILL)
stiff, black - grey, locally oxidized, trace silt, sand, and rootlets
-becomes brownish green, trace black pockets and wood
CLAY
stiff, brown, silty, trace to some silt
-trace sand
CLAY (TILL)
very stiff, brown, sandy, trace coal, pebbles, and oxide staining
SAND
compact, brown, fine grained
CLAY (TILL)
hard, brown, sandy, trace pebbles, coal, and sand pockets
-occasional fine sand lenses
-becomes grey, some sand, trace oxide staining
Open > 215 kPa
THURBER ENGINEERING LTD.
FIELD LOGGED BY: CW
PREPARED BY: AVK
REVIEWED BY:
COMPLETION DEPTH: 30.4 m
COMPLETION DATE: 24/7/06
Page 1 of 2


CLIENT: CARTER TECH (CANADA) INC.
PROJECT: Lynwood Ravine Drainage Design and Construction
BOREHOLE NO: TH06-1
DRILLING COMPANY: Mobile Augers & Research Ltd.
DATE DRILLED: July 24, 2006
PROJECT NO: 19-3495-06
DRILL METHOD: Solid Stem Augers
LOCATION: See Drawing #19-3495-06-1
ELEVATION: 665.93 (m)
SAMPLE TYPE
GRAB SAMPLE
SPT
REMARKS
SOIL DESCRIPTION
CLAY (TILL) - CONTINUED
END OF TEST HOLE AT 10.4m
UPON COMPLETION: (Below ground surface)
Slough at 5.0m
-No water
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-July 24, 2006 = Dry
-August 10, 2006 = 7.06m
THURBER ENGINEERING LTD.
FIELD LOGGED BY: CW
PREPARED BY: AMK
REVIEWED BY:
COMPLETION DEPTH: 10.4 m
COMPLETION DATE: 24/7/06
Page 2 of 2


CLIENT: EARTH TECH (CANADA) INC.
PROJECT: Lynwood Ravine Drainage Design and Construction
BOREHOLE NO: TH06-2
DRILLING COMPANY: Valdo Augers & Research Ltd.
DATE DRILLED: July 24, 2006
PROJECT NO: 19-2485-00
DRILL METHOD: Solid & Hollow Stem Auger
LOCATION: See Drawing #19-2485-00-1
ELEVATION: 667.56 (m)
SAMPLE TYPE
SPT
SHELBY TUBE
BACKFILL TYPE
DEPTH (m)
SAMPLE TYPE
SPT (N)
REMARKS
SOILS PROFILE
USCS
SOIL SYMBOL
SOIL DESCRIPTION
ELEVATION (m)
PLASTIC
NATURAL
LIQUID
TOPSOIL
CLAY (FILL)
very stiff, black - grey, locally oxidized, trace white silt pockets and pebbles
-some organic staining, trace to some sand
SAND (FILL)
compact, brown, fine grained, trace clay lumps
CLAY (TILL)
very stiff, brown, silty, sandy, trace pebbles, gravel, coal, and oxidations
-trace very fine to fine grey sand pockets
-becomes brownish grey
-trace silt pockets
-becomes hard, fine brown sand lenses
Qpen > 215kPa
Qpen > 215kPa
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
FIELD LOGGED BY: CW
PREPARED BY: AMK
REVIEWED BY:
COMPLETION DEPTH: 13.4 m
COMPLETION DATE: 24/7/06
Page 1 of 2

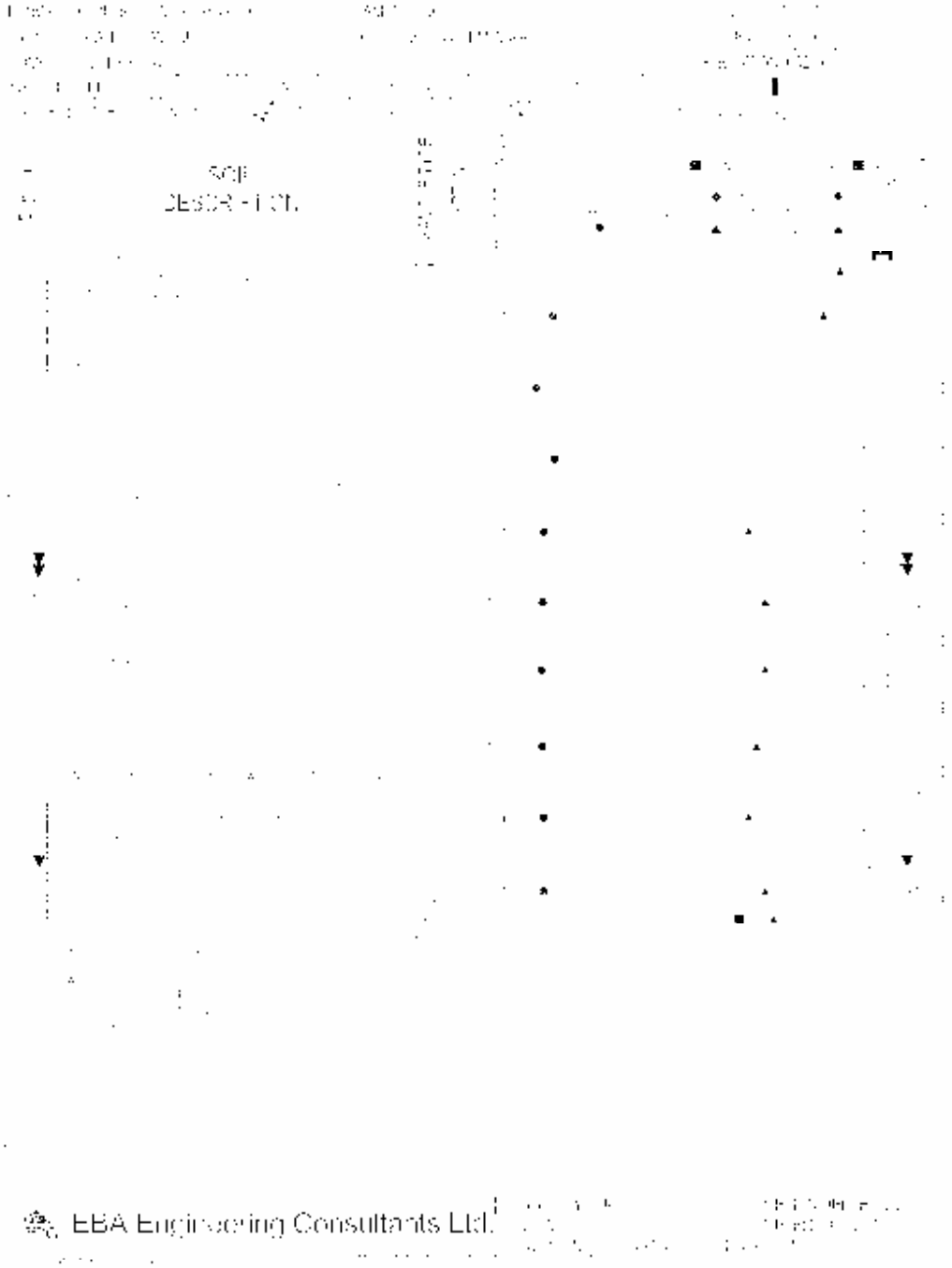

CLIENT: EARTH TECH (CANADA) INC.
PROJECT: Lynwood Ravine Drainage Design and Construction
BOREHOLE NO: TH06-2
DRILLING COMPANY: Middle Aspers & Forward LTD.
DATE DRILLED: July 24, 2006
PROJECT NO: 19-3486-06
DRILLING METHOD: Solid & Hollow Stem Auger
LOCATION: See Drawing #19-3486-06-1
ELEVATION: 667.58 (m)
SAMPLE TYPE
GRAB SAMPLE
SHELBY TUBE
BACKFILL TYPE
OPEN STANDPIPE
DEPTH (m)
SAMPLE TYPE
SPT (N)
REMARKS
SCATTERED RECOVERIES
USC
SOIL SYMBOL
SOIL DESCRIPTION
ELEVATION (m)
-CLAY (TILL) - CONTINUED
-trace coal pieces, occasional sand pockets / lenses
END OF TEST HOLE AT 10.4m
UPON COMPLETION:
-No slough
-No water
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-July 24, 2006 = Dry
August 10, 2006 = Dry
THURBER ENGINEERING LTD.
LOGGED BY: CW
CHECKED BY: AMC
REVIEWED BY:
COMPLETION DEPTH: 10.4 m
COMPLETION DATE: 24/7/06
Page 2 of 2

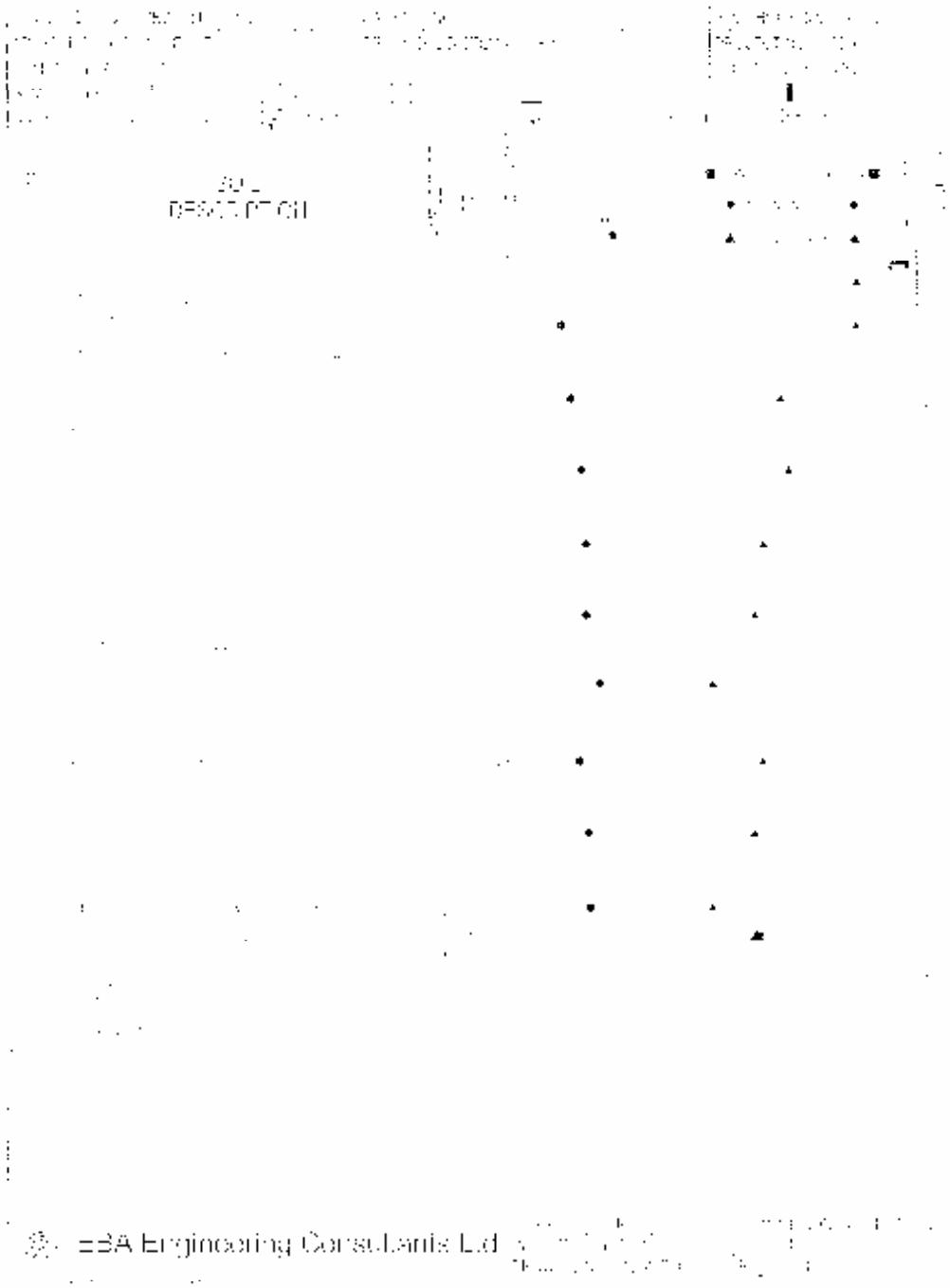

CLIENT: EARTHTECH (CANADA) INC.
PROJECT: Lynwood Ravine Drainage Design and Construction
BOREHOLE NO. TH08-3
DRILLING COMPANY: Wade Augers & Research Ltd.
DATE DRILLED: July 24, 2008
PROJECT NO. 19-0485-06
DRILLING METHOD: Solid & Hollow Stem Auger
LOCATION: See Drawing #19-0485-06-1
ELEVATION: 609.19 (m)
SAMPLE TYPE
GRAB SAMPLE
SPT
SHELBY TUBE
BACKFILL TYPE
DRILL CUTTINGS
SLOUGH
SOIL DESCRIPTION
REMARKS
TOPSOIL
CLAY (FILL)
stiff, brown - black, trace sand, rootlets, and oxide staining
-trace silt and white silt pockets
-trace glass and wood
CLAY
firm, brown, silty, trace silt
-trace coal
becomes grey - green - black
SAND, compact, grey, fine grained
CLAY (TILL)
stiff, brown, sandy, trace oxide staining and coal, occasional fine sand lenses / pockets
SAND
grey, fine grained
-50mm thick clay pockets
CLAY (TILL)
hard, grey, sandy, trace coal and pebbles
-Gravel = 0.0%
Sand = 8.0%
Silt = 51.5%
Clay = 39.5%
-SO4 = 0.06%
Open > 215kPa
THURBER ENGINEERING LTD.
FIELD LOGGED BY: DW
COMPLETION DEPTH: 10.2 m
PREPARED BY: AAW
COMPLETION DATE: 24/7/08
REVIEWED BY:
Page 1 of 2

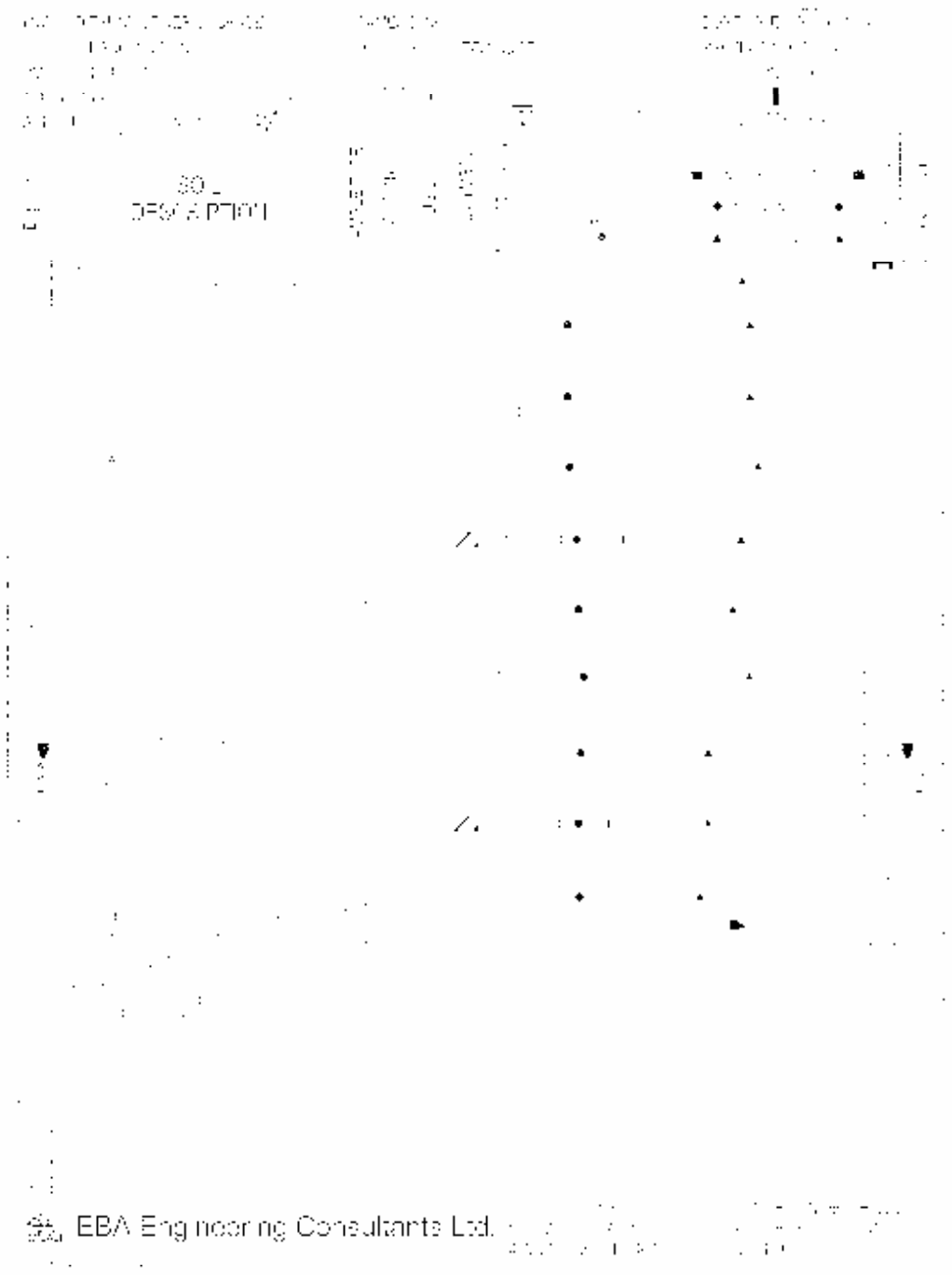

PROJECT: Lynwood Ravine Drainage Design and Construction
BOREHOLE NO: TH96-3
DATE DRILLED: July 24, 2006
PROJECT NO: 19-3465-96
LOCATION: See Drawing #19-3465-96-1
ELEVATION: 662.15 (m)
SOIL DESCRIPTION
REMARKS
CLAY (FILL) - CONTINUED
END OF TEST HOLE AT 10.2m
UPON COMPLETION: (Below ground surface)
-Slough at 7.0m
-No water
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-July 24, 2006 - Dry
-August 09, 2006 - 5.12m
THURBER ENGINEERING LTD.
Page 2 of 2

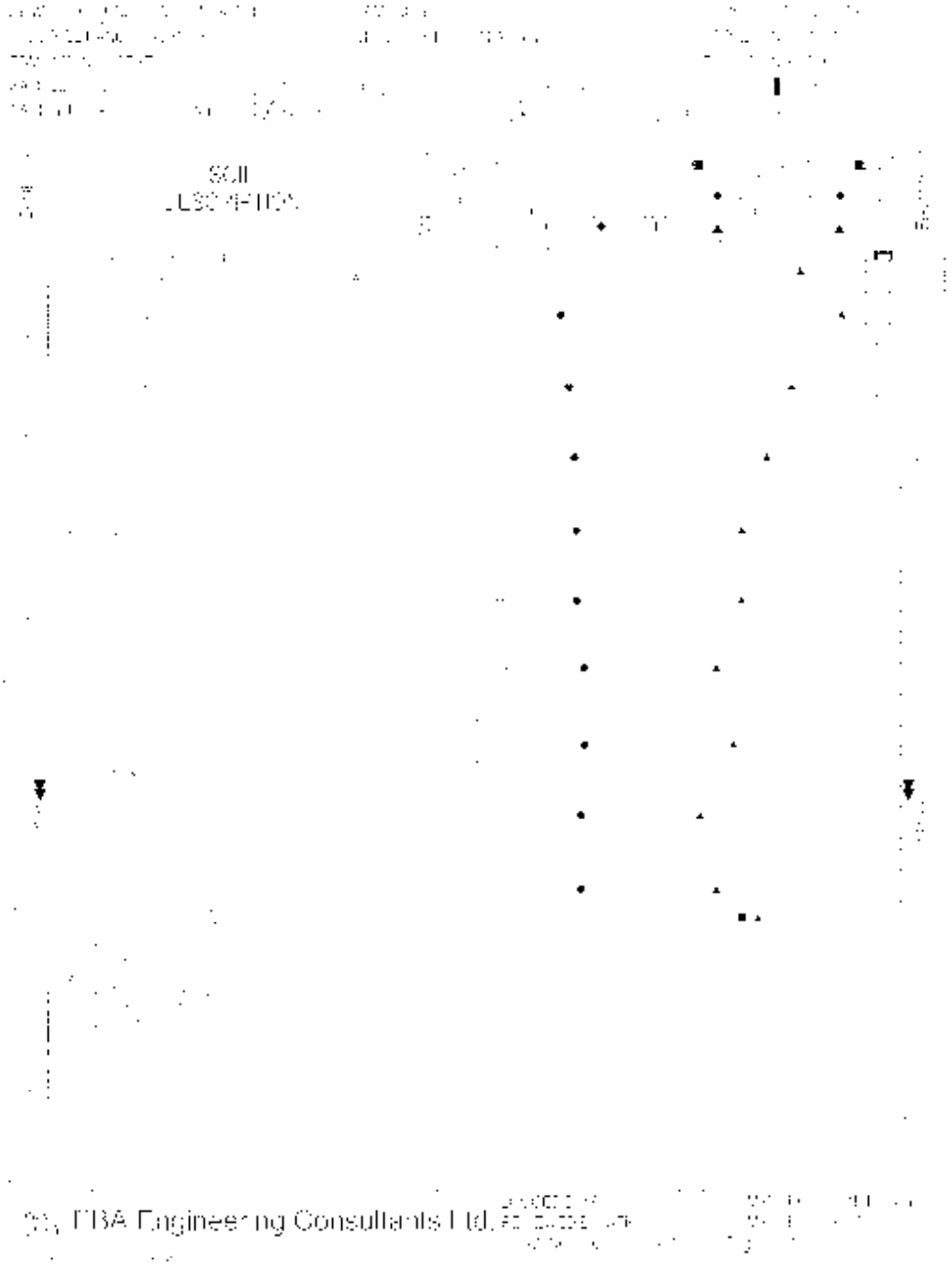
Appendix F. Geotechnical Borehole Logs for the LY4 Project (Small Ravine)

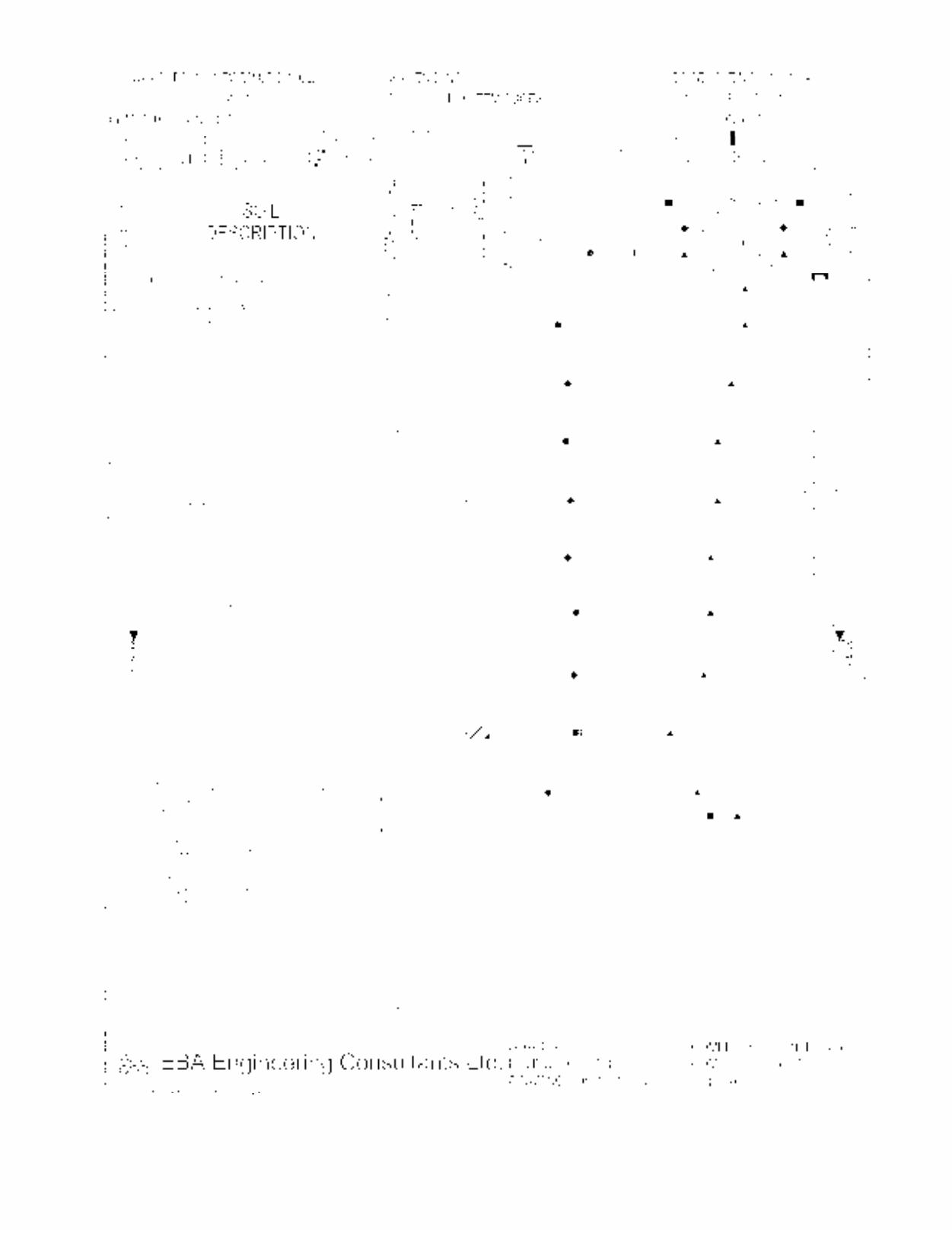
These borehole logs contain detailed information about the soils and groundwater of the LY4 ravine. The boreholes were drilled by EBA Engineering Consultants, who placed five test holes at various sites within the LY4 on July 31 and August 9, 2006 (see Figure 1.3).


EBA Engineering Consultants Ltd.




EBA Engineering Consultants Ltd.





Appendix G. Vegetation of the Lynnwood Ravine

A reconnaissance level vegetation survey was done on October 18, 2006, with the view to producing a basic vegetation map. As such, and given the late time of year, the survey concentrated on tree and shrub layers and did not evaluate the forb or graminoid layers or look for possible rare species. The following is a list of all species found within the Main and Small ravines.

Common Name	Scientific Name	Vegetative Layer
Balsam Poplar	Populus blasamifera	Tree
Trembling Aspen	Populus tremuloides	Tree, Shrub
Big-toothed Aspen	Populus grandidentata	Tree
White Spruce	Picea glauca	Tree. Shrub
Norway Spruce	Picea abies	Tree
Blue Spruce	Picea pungens	Tree
Jackpine	Pinus banksiana	Tree
Western Mountain-Ash	Sorbus scopulina	Tree, Shrub
Manitoba Maple	Acer nigundo	Tree
Paper Birch	Betula papyrifera	Tree
Crabapple	Malus sp.	Tree
Laurel Leaf Willow	Salix pentandra	Tree
American Elm	Ulmus americana	Tree
Beaked Hazelnut	Corylus cornuta	Shrub
Pin Cherry	Prunus pennsylvanica	Shrub
Choke Cherry	Prunus virginiana	Shrub
Willow	Salix sp.	Shrub
Lilac	Syringa sp.	Shrub
Cotoneaster	Cotoneaster sp.	Shrub
Saskatoon	Amelanchier alnifolia	Shrub
Low Bush Cranberry	Viburnum edule	Shrub
High Bush Cranberry	Viburnum trilobum	Shrub
Prickly Rose	Rosa acicularis	Shrub
Northern Gooseberry	Ribes oxyacanthoides	Shrub
Red-osier Dogwood	Cornus stolonifera	Shrub
Western Snowberry	Symphoricarpos occidentalis	Shrub
Wild Red Raspberry	Rubus idaeus	Shrub
Twining Honeysuckle	Lonicera dioica	Shrub
Meadowsweet	Spirea sp.	Shrub
Cinquefoil	Potentilla sp.	Shrub
White Clover	Trifolium repens	Forb
Dandelion	Taraxacum officinale	Forb
Canada Thistle	Cirsium arvense	Forb
Common Plantain	Plantago major	Forb
Bluejoint	Calamagrostis Canadensis	Grass
Kentucky Blue Grass	Poa pratensis	Grass

Appendix H. Plant Species within Each Plant Community

Plant Species Cover Estimate		
C	Common	Many plants of this species are found throughout the community.
D	Dense	This plant forms a continuous or near-continuous cover in some areas of the community.
O	Occasional	This plant is encountered in just a few localities within the community.
U	Uncommon	Only one or two plants of this species is found in the community.

Species occurrence in the P1 (Balsam Poplar/White Spruce) plant community

Species	Tree	Tall shrub	Medium shrub	Low shrub	Forbs, Grasses
Balsam Poplar	C				
Trembling Aspen	O				
White Spruce	O				
Western Mountain-Ash	O	O			
Beaked Hazelnut			C		
Pin Cherry		C			
Willow		O			
Cotoneaster			O		
Saskatoon		C	O		
Low Bush-Cranberry				O	
Prickly Rose			C		
Northern Gooseberry			O	O	
Red-osier Dogwood		O	O		
Bluejoint					C

Species occurrence in the P2 (Balsam Poplar/Aspen) plant community.

Species	Tree	Tall shrub	Medium shrub	Low shrub	Forbs, Grasses
Balsam Poplar	C		O		
Trembling Aspen	C	C-D	C-D		
White Spruce	O				
Western Mountain-Ash			O		
Manitoba Maple	O				
Crabapple	O				
Pin Cherry		C	C		
Saskatoon			O		
Prickly Rose				C	
Northern Gooseberry				O	
Red-osier Dogwood		C	C		
Western Snowberry				O	
Bluejoint					D

Species occurrence in the AP1 (Aspen/Balsam Poplar 1) plant community.

Species	Tree	Tall shrub	Medium shrub	Low shrub	Forbs, Grasses
Trembling Aspen	D	C			
Balsam Poplar	O	O			
White Spruce				O	
Pin Cherry		D			
Lilac		O			
Saskatoon		O	D		
Prickly Rose			D	O	
Red-osier Dogwood		D			
Western Snowberry				D	
Wild Red Raspberry			O		
Twining Honeysuckle			O		
Canada Thistle					D
Bluejoint					D

Species occurrence in the AP3 (Aspen/Balsam Poplar 3) plant community.

Species	Tree	Tall shrub	Medium shrub	Low shrub	Forbs, Grasses
Trembling Aspen	C	O			
Balsam Poplar	C	O			
White Spruce	O				
Pin Cherry		O			
Saskatoon		O	C		
Prickly Rose			C-D	C	
Red-osier Dogwood		C-D	C		
Western Snowberry				O	
Bluejoint					C

Species occurrence in the W1 (White Spruce/Balsam Poplar) plant community.

Species	Tree	Tall shrub	Medium shrub	Low shrub	Forbs, Grasses
White Spruce	C				
Trembling Aspen	O				
Balsam Poplar	C				
Manitoba Maple	O				
Paper Birch	O				
Pin Cherry		C-D			
Lilac		C			
Saskatoon		O	O		
Low Bush-Cranberry			O		
High Bush Cranberry		O			
Red-osier Dogwood		C-D	C		
Bluejoint					C

Species occurrence in the WM (Willow/Manitoba Maple) plant community.

Species	Tree	Tall shrub	Medium shrub	Low shrub	Forbs, Grasses
Laurel Leaf Willow	C				
Manitoba Maple	C				
Western Mountain-Ash	C				
Jackpine	O				
White Spruce	O				
Pin Cherry		O			
Cotoneaster			O		
Kentucky Blue Grass					D

Appendix I. Birds of the Lynnwood Ravine and Surrounding Region

Reg Stat	Regional Status	Status within the Edmonton region. B = breeding; M = migrant; R = resident; W = winter visitor; ? = status uncertain.
Use Rv	Use Ravine	Likely uses the ravine ad/or adjacent uplands during the year for purposes other than just as breeding habitat or a migratory stopover point.
Breed	Breed in Ravine	Likely uses the ravine or adjacent uplands for breeding activities.
Migr	Migrant	Found in the ravine or adjacent uplands during migration season.
Res	Resident	Year-round resident.
WV	Winter Visitor	Generally found in the ravine or adjacent uplands only during the winter months.

Common Name	Scientific Name	Reg Stat	Use Rv	Breed	Migr	Res	WV
Alder Flycatcher	*Empidonax alnorum*	B			X		
American Crow	*Corvus brachyrhynchos*	B	X	X	X		X
American Goldfinch	*Carduelis tristis*	B	X	X	X		X
American Kestrel	*Falco sparverius*	B			X		
American Pipit	*Anthus rubescens*	M					
American Redstart	*Setophaga ruticilla*	B			X		
American Robin	*Turdus migratorius*	B	X	X	X		X
American Tree Sparrow	*Spizella arborea*	B			X		
Bank Swallow	*Riparia riparia*	B			X		
Barn Swallow	*Hirundo rustica*	B			X		
Barred Owl	*Strix varia*	R					
Bay-breasted Warbler	*Dendroica castanea*	M			X		
Belted Kingfisher	*Ceryle alcyon*	B			X		
Black-and-white Warbler	*Mniotilta varia*	B			X		
Black-backed Woodpecker	*Picoides arcticus*	R	X				
Black-billed Cuckoo	*Coccyzus erythropthalmus*	B	X				
Black-billed Magpie	*Pica hudsonia*	R	X	X		X	X

Common Name	Scientific Name	Reg Stat	Use Rv	Breed	Migr	Res	WV
Blackburnian Warbler	*Dendroica fusca*	M			X		
Black-capped Chickadee	*Poecile atricapillus*	R	X	X		X	X
Blackpoll Warbler	*Dendroica striata*	B			X		
Black-Throated Green Warbler	*Dendroica virens*	M			X		
Blue Jay	*Cyanocitta cristata*	R	X	X		X	X
Blue-headed Vireo/ Solitary Vireo	*Vireo solitarius*	B			X		
Bohemian Waxwing	*Bombycilla garrulus*	B	X		X		X
Bonaparte's Gull	*Larus philadelphia*	B			X		
Boreal Chickadee	*Poecile hudsonica*	R	X				X
Brewer's Blackbird	*Euphagus cyanocephalus*	B	X		X		
Broad-winged Hawk	*Buteo platypterus*	B			X		
Brown Creeper	*Certhia americana*	R	X				
Brown Thrasher	*Toxostoma rufrum*	B					
Brown-headed Cowbird	*Molothrus ater*	B			X		
California Gull	*Larus californicus*	B	X		X		
Canada Warbler	*Wilsonia canadensis*	B			X		
Cape May Warbler	*Dendroica tigrina*	M			X		
Cedar Waxwing	*Bombycilla cedrorum*	B	X		X		X
Chestnut-collared Longspur	*Calcarius ornatus*	B			X		
Chestnut-sided Warbler	*Dendroica pensylvanica*	M			X		
Chipping Sparrow	*Spizella passerina*	B	X	X	X		
Clay-colored Sparrow	*Spizella pallida*	B	X	X	X		
Cliff Swallow	*Petrochelidon pyrrhonota*	B			X		
Common Grackle	*Quiscalus quiscala*	B	X	X	X		
Common Nighthawk	*Chordeiles minor*	B			X		
Common Raven	*Corvus corax*	R					X
Common Redpoll	*Carduelis flammea*	W/B	X				X
Common Yellowthroat	*Geothypis trichas*	B			X		
Connecticut Warbler	*Oporornis agilis*	B			X		
Cooper's Hawk	*Accipiter cooperii*	B	X		X		X
Dark-eyed Junco	*Junco hyemalis*	B			X		

Common Name	Scientific Name	Reg Stat	Use Rv	Breed	Migr	Res	WV
Downy Woodpecker	*Picoides pubescens*	R	X	X		X	X
Eastern Bluebird	*Sialia sialis*	B					
Eastern Kingbird	*Tyrannus tyrannus*	B					
Eastern Phoebe	*Sayornis phoebe*	B			X		
European Starling	*Sturnus vulgaris*	B	X	X	X	X	X
Evening Grosbeak	*Coccothraustes vespertinus*	R					X
Fox Sparrow	*Passerella iliaca*	B			X		
Franklin's Gull	*Larus pipixcan*	B	X				
Glaucous Gull	*Larus hyperboreus*	M					X
Golden Eagle	*Aquila chrysaetos*	B			X		
Golden-crowned Kinglet	*Regulus satrapa*	B	X		X		
Gray Catbird	*Dumetella carolinensis*	B	X	X	X		
Gray Jay	*Perisoreus canadensis*	R					
Gray Partridge	*Perdix perdix*	R	X	X			X
Gray-cheeked Thrush	*Catharus minimus*	M			X		
Great Grey Owl	*Strix nebulosa*	R			X		
Great Horned Owl	*Bubo virginianus*	R	X				X
Great-crested Flycatcher	*Myiarchus crinitus*	B					
Hairy Woodpecker	*Picoides villosus*	R	X	X		X	X
Harris's Sparrow	*Zonotrichia querula*	M			X		
Hermit Thrush	*Catharus guttatus*	B			X		
Herring Gull	*Larus argentatus*	B			X		
Hoary Redpoll	*Carduelis hornemanni*	W					X
Horned Lark	*Eremophila alpestris*	B			X		
House Finch	*Carpodacus mexicanus*	R	X				
House Sparrow	*Passer domesticus*	R	X	X		X	X
House Wren	*Troglodytes aedon*	B	X				
Lapland Longspur	*Calcarius lapponicus*	M					X
Le Conte's Sparrow	*Ammodramus leconteii*	B			X		
Least Flycatcher	*Empidonax minimus*	B	X	X			
Lincoln's Sparrow	*Melospiza lincolnii*	B			X		
Long-eared Owl	*Asio otus*	B					X
Magnolia Warbler	*Dendroica magnolia*	B			X		
Marsh Wren	*Cistothorus palustris*	B					

Common Name	Scientific Name	Reg Stat	Use Rv	Breed	Migr	Res	WV
McCown's Longspur	*Calcarius mccownii*	B			X		
Merlin	*Falco columbarius*	B	X	X	X	X	X
Mew Gull	*Larus canus*	M					
Mountain Bluebird	*Sialia currucoides*	B					
Mourning Dove	*Zenaida macroura*	B	X		X		
Mourning Warbler	*Oporonis philadelphia*	B			X		
Nelson's Sharp-tailed Sparrow	*Ammodramus nelsoni*	B			X		
Northern Flicker	*Colaptes auratus*	B	X	X	X		
Northern Goshawk	*Accipiter gentilis*	B					
Northern Harrier	*Circus cyaneus*	B			X		
Northern Hawk Owl	*Surnia ulula*	W					
Northern Oriole	*Icterus galbula*	B	X		X		
Northern Pygmy-Owl	*Glaucidium gnoma*	R			X		
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	B			X		
Northern Saw-whet Owl	*Aegolius acadicus*	R			X		X
Northern Waterthrush	*Seiurus noveboracensis*	B			X		
Olive-sided Flycatcher	*Contopus cooperi*	B	X				
Orange-crowned Warbler	*Vermivora celata*	B			X		
Ovenbird	*Seiurus aurocapillus*	B	X		X		
Palm Warbler	*Dendroica palmarum*	B					
Peregrine Falcon	*Falco pergrinus anatum*	B					X
Philadelphia Vireo	*Vireo philadelphicus*	B	X	X	X		
Pileated Woodpecker	*Dryocopus pileatus*	R	X			X	X
Pine Grosbeak	*Pinicola enucleator*	W					X
Pine Siskin	*Carduelis pinus*	R/B	X	X			
Purple Finch	*Carpodacus purpureus*	B	X	X	X		X
Purple Martin	*Progne subis*	B			X		
Red Crossbill	*Loxia curvirostra*	R					X
Red-breasted Nuthatch	*Sitta canadensis*	R	X	X		X	X
Red-eyed Vireo	*Vireo olivaceus*	B	X	X	X		
Red-tailed Hawk	*Buteo jamaicensis*	B	X		X		

Common Name	Scientific Name	Reg Stat	Use Rv	Breed	Migr	Res	WV
Red-winged Blackbird	*Agelaius phoeniceus*	B	X		X		
Ring-billed Gull	*Larus delawarensis*	B	X		X		
Ring-necked Pheasant	*Phansianus colchicus*	R	X				X
Rock Pigeon	*Columba livia*	R	X			X	X
Rose-breasted Grosbeak	*Pheucticus ludovicanus*	B			X		
Rough-legged Hawk	*Buteo lagopus*	M			X		
Ruby-crowned Kinglet	*Regulus calendula*	B			X		
Ruby-throated Hummingbird	*Archilochus colubris*	B			X		
Ruffed Grouse	*Bonasa umbellus*	R	X				X
Rufous Hummingbird	*Selasphorous rufus*	?			X		
Rusty Blackbird	*Euphagus carolinus*	B			X		
Savannah Sparrow	*Passerculus sandwichensis*	B			X		
Sedge Wren	*Cistothorus platensis*	B					
Sharp-shinned Hawk	*Accipiter striatus*	B	X		X		X
Sharp-tailed grouse	*Tympanuchus phasianellus*	R	X				
Short-eared Owl	*Asio flammeus*	R	X				
Snow Bunting	*Plectrophenax nivalis*	W			X		X
Snowy Owl	*Nyctea scandiaca*	W	X				X
Song Sparrow	*Melospiza melodia*	B	X	X	X		
Spotted Towhee	*Pipilo maculatus*	B			X		
Sprague's Pipit	*Anthus spragueii*	B	X				
Swainson's Hawk	*Buteo swainsoni*	B			X		
Swainson's Thrush	*Catharus ustulatus*	B			X		
Tennessee Warbler	*Vermivora peregrina*	B	X	X	X		
Three-toed Woodpecker	*Picoides tridactylus*	R	X				
Townsend's Solitaire	*Myadestes townsrndi*	M			X		
Tree Swallow	*Tachycineta bicolor*	B	X		X		
Varied Thrush	*Ixoreus naevius*	B			X		
Veery	*Catharus fuscescens*	B			X		
Vesper Sparrow	*Pooecetes gramineus*	B			X		
Warbling Vireo	*Vireo gilvus*	B	X	X	X		
Western Kingbird	*Tyrannus verticalus*	B			X		

Common Name	Scientific Name	Reg Stat	Use Rv	Breed	Migr	Res	WV
Western Meadowlark	*Sturnella neglecta*	B	X				
Western Tanager	*Piranga ludoviciana*	B			X		
Western Wood-pewee	*Contopus sordidulus*	B			X		
White-breasted Nuthatch	*Sitta carolinensis*	R	X	X		X	X
White-crowned Sparrow	*Zonotrichia leucophrys*	B			X		
White-throated Sparrow	*Zonotrichia albicollis*	B	X	X	X		
White-winged Crossbill	*Loxia leucoptera*	R					X
Wilson's Warbler	*Wilsonia pusilla*	B			X		
Winter Wren	*Troglodytes troglodytes*	M			X		
Yellow Warbler	*Dendroica petechia*	B	X	X	X		
Yellow-bellied Flycatcher	*Empidonax flaviventris*	M			X		
Yellow-bellied Sapsucker	*Sphyrapicus varius*	B	X	X	X		
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	B			X		
Yellow-rumped Warbler	*Dendroica coronata*	B			X		

Appendix J. Mammals of the Lynnwood Ravine and Surrounding Region

This list represents those species which could potentially be found within the LY3 and/or LY4 ravines. As such, this list also contains numerous species which are unlikely to be found in the Lynnwood Ravine, either due to:

- the small size of the undisturbed habitats within the ravine, or
- its use as a wildlife corridors is severely limited because it is cut off from the North Saskatchewan River valley by the Whitemud Freeway.

The provincial status rating is the population status of that species within the entire province of Alberta.

Common Name	Scientific Name	Provincial Status
Masked Shrew	*Sorex cinereus*	Secure
Hayden's Shrew/Prarie Shrew	*Sorex haydeni*	Secure
Arctic Shrew	*Sorex arcticus*	Secure
Pygmy Shrew	*Sorex hoyi*	Secure
Little Brown Bat	*Myotis lucifugus*	Secure
Northern Bat	*Myotis septentrionalis*	May Be at Risk
Silver-haired Bat	*Lasionycteris noctivagans*	Secure
Big Brown Bat	*Eptesicus fuscus*	Secure
Hoary Bat	*Lasiurus cinereus*	Secure
Snowshoe Hare	*Lepus americanus*	Secure
White-tailed Jack Rabbit	*Lepus townsendii*	Secure
Least Chipmunk	*Tamias minimus*	Secure
Woodchuck	*Marmota monax*	Secure
Richardson's Ground Squirrel	*Spermophilus richardsonii*	Secure
Thirteen-lined Ground Squirrel	*Spermophilus tridecemlineatus*	Undetermined
Franklin's Ground Squirrel	*Spermophilus franklinii*	Undetermined
Red Squirrel	*Tamaisciurus hudsonicus*	Secure
Northern Flying Squirrel	*Glaucomys sabrinus*	Secure
Northern Pocket Gopher	*Thomomys talpoides*	Secure
Deer Mouse	*Peromyscus maniculatus*	Secure
Southern Red-backed Vole	*Clethrionomys gapperi*	Secure
Heather Vole	*Phenacomys intermedius*	Secure
Meadow Vole	*Microtus pennsylvanicus*	Secure
Long-tailed Vole	*Microtus longicaudus*	Secure
Prairie Vole	*Microtus ochrogaster*	Undetermined
House Mouse	*Mus musculus*	Exotic/Alien
Meadow Jumping Mouse	*Zapus hudsonius*	Secure
Western Jumping Mouse	*Zapus princeps*	Secure
Common Porcupine	*Erethizon dorsatum*	Secure

Common Name	Scientific Name	Provincial Status
Coyote	*Canis latrans*	Secure
Red Fox	*Vulpes vulpes*	Secure
Black Bear	*Ursus americanus*	Secure
Long-tailed Weasel	*Mustela frenata*	May Be at Risk
Ermine	*Mustela erminea*	Secure
Least Weasel	*Mustela nivalis*	Secure
American Badger	*Taxidea taxus taxus*	Sensitive
Striped Skunk	*Mephitis mephitis*	Secure
Mountain Lion/Cougar	*Felis concolor*	Sensitive
Mule Deer	*Odocoileus hemionus*	Secure
White-tailed Deer	*Odocoileus virginianus*	Secure

Appendix K. Lepidoptera of the Lynnwood Ravine and Surrounding Region

Common Name	Scientific Name	Species Habitat in the Edmonton Region
Silver-Spotted Skipper	*Epargyreus clarus*	Clearings in aspen woods, edges of poplar groves, wooded ravines
Northern Cloudywing	*Thorybes pylades*	Inside and along the edges of poplar forests and pine forests
Persius Duskywing	*Erynnis persius*	Open forests, forest clearings, forest edges, river valleys
Checkered Skipper	*Pyrgus communis*	Aspen parkland
Arctic Skipper	*Carterocephalus palaemon*	Meadows, clearings and open stands of pine, mixedwod and poplar forests
Common Branded Skipper	*Hesperia comma*	Aspen parkland, grassy sides of valleys
Long Dash Skipper	*Polites mystic*	Aspen parkland, weedy areas, meadows
Peck's Skipper	*Polites peckius*	Grassy and weedy areas of the aspen parkland
Tawny-Edged Skipper	*Polites themistocles*	Aspen parkland, moist grasslands, along creeks
Roadside Skipper	*Amblyscirtes vialis*	Poplar forests and forest clearings; riparian forests along rivers
Canadian Tiger Swallowtail	*Papilio canadensis*	Mixedwood forest, edges of aspen parkland
Cabbage White	*Pieris rapae*	Disturbed areas, virtually all habitats near vegetable gardens or weedy areas
Large Marble	*Euchloe ausinodes*	Aspen parkland, dry meadows in mixedwood forest, pine forests
Spring Azure	*Celastrina ladon*	Habitats with Cranberry *(Viburnum* sp.*),* Huckleberry *(Vaccinium* sp.) and Cherry *(Prunus* sp.), and Red-osier Dogwood (*Cornus stolonifera*)
Greenish Blue	*Plebejus saepiolus*	All habitats, especially ones with clover and other legumes
Aphrodite Fritillary	*Speyeria aphrodite*	Aspen woodlands, riaprian forests, jackpine forests, native prairie grasslands
Mormon Fritillary	*Speyeria mormonia*	Prairie grasslands, mixedwood forests, forest openings
Green Comma	*Polygonia faunus*	Spruce or mixedwood forests

Common Name	Scientific Name	Species Habitat in the Edmonton Region
Mourning Cloak	*Nymphalis antiopa*	All habitats, especially poplar woods
Compton Tortoiseshell	*Nymphalis vaualbum*	Deciduous forests especially along openings, trails and forest edges
Zephyr	*Polygonia zephyrus*	Coniferous and mixedwood forests
Painted Lady	*Vanessa cardui*	Almost all habitats but prefererably fields, gardens and disturbed areas near Thistle (*Cirsium* sp.) patches
Red Admiral	*Vanessa atalanta*	Almost all habitat types, often along streams and meadows
American Painted Lady	*Vanessa virginiensis*	Virtually all habitat types
White Admiral	*Limenitis arthemis*	Edges of Poplar, Aspen and White Birch forests
Viceroy	*Limenitis archippus*	Meadows, edges of fields near Willows, Poplars and Cherry (*Prunus* sp.) bushes
Macoun's Arctic	*Oeneis macounii*	Pine and aspen forests