HOPEWELL DEVELOPMENT CORPORATION
REMEDIAL ACTION PLAN FOR THE USE OF LIME MUD FOR LANDSCAPING

Submitted to:
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AMEC Project No: WX17301

Executive Summary

Hopewell Development Corporation is in the process of redeveloping land near the former Rogers Sugar Company Site in Winnipeg Manitoba. This Site has several large stockpiles of lime mud, a by-product of sugar production, located on the Site. Manitoba Conservation and Water Stewardship (MCWS) has requested that a modified Remedial Action Plan (RAP) be submitted for approval. The RAP is required to outline the extent of the stockpiles and the plan for utilizing or removing the piles from the Site.

After reviewing the extensive documentation that is currently available for the lime mud and associated sites, it was determined that the best use of the by-product was for the construction of landscape features in the form of berms around the future development (Hervo Site). Due to the volume of the product (490,000 m^3) it was determined that a second location would be required in order to successfully remove all of the stockpiled lime mud. Negotiations with the City of Winnipeg have indicated a need for berm construction around the perimeter of the Brady Landfill site, which could utilize the remainder of the stockpiled by-product.

Due to the nature of the lime mud, MCWS requested that the utilization be evaluated for its potential effects on surface water, ground water and air quality. After review of the characteristics of the lime mud, it was decided that using the material for fill within the berms, and covering with .05 to 1 m of clay. For the Hervo Site fill slopes, generally in the range of about 6:1 (H:V) to 8:1 (H:V), are proposed. For the Brady Road site, these will be designed as a 5 m wide crest with 3.86H:1V slopes. These configurations would substantially reduce the potential for impacts from the project.

Due to the high volume of material associated with the project, it is expected that the remediation will take place over a number of years, with work beginning in 2014.

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1.0 INTRODUCTION

1.1 Project Background and Terms of Reference

Mr. Don Larke of Hopewell Development Corporation authorized AMEC Earth & Environmental, a division of AMEC Americas Limited (AMEC), to review the potential for impacts to the environment from plans related to the use of Lime Mud from the former Rogers Sugar operation property located near Bishop Grandin Boulevard (Hervo Site) in Winnipeg, Manitoba. This location has a stockpile of lime mud by-product that was generated over several years of operation by the Rogers Sugar Company. The estimated volume of the stockpile is 490,000 m^3. After calculating the required volumes, it was determined that a second location would be required in order to successfully remove all of the stockpiled lime mud. Negotiations with the City of Winnipeg have indicated a need for berm construction around the perimeter of the Brady Landfill site (Brady Site), which could utilize the remainder of the stockpiled by-product.

Discussions with Manitoba Conservation and Water Stewardship (MCWS) indicated that lime mud, which has an elevated pH level, could not be moved until approved by their department. MCWS requested that they be provided with a Remedial Action Plan (RAP) that would contain information that would:

- Discuss the known characteristics and composition of the lime mud;
- Estimate the potential for impacts to surface water, ground water and air quality;
- Present a preliminary design of the use of the lime mud and the estimated volumes; and
- Provide an estimate of the timeline for the RAP.

As part of the overall planning, uses for the Lime Mud were investigated, and a plan for the disposal of the product developed. This RAP describes the proposed disposition of the lime mud off of the former Rogers Sugar Company property, and is based on:

- AMEC Letter Report to Don Larke **Re: Bishop Grandin Lime Mud Remediation Plan,** December 20, 2013
- AMEC Letter Report to Don Larke **Re: Brady Road Landfill Lime Mud Remediation Plan (Revised for New Slope Alignment),** February 7, 2013
- AMEC Letter Report to Don Larke **Re: Bishop Grandin Lime Mud Remediation Plan Potential for Environmental Effects**, January 10, 2013
- AMEC Letter Report to Don Larke **Re: Brady Landfill Lime Mud Remediation Plan Potential for Environmental Effects**, January 10, 2013

Excerpts from these four documents were used to construct this report.

Berms are proposed to be constructed, (see Appendix A) utilizing the on-Site stockpiles of Lime Mud waste which were historically generated by the Sugar Beet plant operations. The use of the stockpiled material is predicated on the need for materials, the suitability of the materials and the final design for Site landscaping and structural features. It is anticipated that by utilizing both the Hervo and Brady Landfill sites (hereafter referred to as “the Hervo Site” and “Brady Site” or collectively as “the Sites”), that the entire stockpile of lime mud will be utilized and removed from the current location.

2.0 LIME MUD ORIGIN AND CHARACTERISTICS

Lime mud is created when water used in the manufacturing process is treated with a lime "milk" (calcium hydroxide solution) to remove impurities. The resulting lime "cake" is separated and pumped into a lime pond on the factory grounds where it has accumulated over the years. Periodically, these lime ponds were scraped and the resulting stockpiles built up as they exist today. Lime mud varies in composition, and is used as a soil amendment in both Canada and the United States. One of the primary benefits of the use of lime mud for this purpose is the small particle size associated with the lime mud compared to regular limestone, and the ease with which it is incorporated into the soil. However, in Manitoba, Lime mud is not commonly used as a soil treatment, as most soils tend to be neutral to basic in nature, and do not require additives that would increase pH.

2.1 Lime Mud Description and Analysis for the Project

The following information is from investigative results found in the reports titled:

- Preliminary Geotechnical and Environmental Investigation Proposed Commercial Development Former Roger's Sugar Property, Winnipeg, Manitoba 2005
- Lime Mud Evaluation, 555 Hervo Street, Winnipeg, Manitoba. Letter Report 2012

Samples selected for environmental laboratory analysis were submitted to Enviro-Test Laboratories in Winnipeg. Analysis conducted by Enviro-Test Laboratories on the lime mud waste materials consisted of trace metals and pH, which were the parameters of concern based on the previous environmental assessments conducted by Wardrop in 1997.

Samples obtained as part of AMEC's investigation were assessed in comparison to the Canadian Council of Ministers of the Environment's (CCME) 1999 *Canadian Environmental Quality Guidelines* document. Guideline values for the assessment were selected from the generic commercial land use criteria soil summary tables.

During previous investigations, a total of eleven (11) lime mud samples were submitted for laboratory analysis of trace metals and pH. Slightly elevated pH concentrations in soil were detected across the Site, with the highest concentrations (8.3 – 9.1) analyzed in the lime mud samples. An additional sample was submitted from what appeared to be cinder ash within the fill materials, for laboratory analysis of poly-aromatic hydrocarbons (PAH). The results of the confirmatory laboratory analysis conducted on the selected soil samples are summarized in Tables 1 through Table 3 in Appendix 2.

The pH values are not in the range (<2.0 or >12.7) to be classified as a corrosive material under Manitoba Regulation 282/87: Classification Criteria for Products, Substances and Organisms Regulation. The metals' concentrations from the lime mud samples were not in

excess of the CCME guidelines. The PAH concentrations from the soil sample from TP2 was not in excess of the CCME guidelines.

3.0 ALTERNATIVE USES OF LIME MUD FOR THE PROJECT

In order to examine the potential for effects from the Lime Mud, it was necessary to evaluate the fate of the product when utilized for the purposes of berm construction. Other uses for disposal of the Lime Mud at the former Roger's Sugar Site have been examined by AMEC (2005) and include the following:

1. Haul Material Off-Site and Dispose – this could include disposal at the Brady Landfill site. Such an undertaking is possible, although it would require trench construction as per Brady Landfill protocols. This could introduce effects to the water table, and nearby use would need to be examined for potential impacts. Additionally, it is probable that any such disposal would require capping of the Lime Mud in order to reduce potential for dust, as required in the Brady Landfill operating permits.

2. Use Material On-Site – AMEC has determined that the material "as is" is not a suitable fill material due to its characteristics. However, with proper capping with clay and careful design of slopes to reduce erosion, it is suitable for the discussed berm option. Other uses would involve incorporating other material with the Lime Mud, and would not be cost effective (See AMEC 2005 report).

3. Concrete additive - discussions with Lafarge have indicated that the lime mud was not considered suitable based on Lafarge's trials with the material (AMEC 2005).

4. Alternate to Hydrated Lime - The use of the lime mud as an alternate to hydrated lime was also considered, but the pH of the Lime Mud was too low to be economically effective.

5. Asphalt Additive – usually hydrated lime is used for this purposes, and the restrictions noted above would apply.

Therefore, upon examination of the alternatives for use confirm that most likely uses of the Lime Mud is either for the intended purpose of berm construction or disposal at a landfill. It should be noted that the increased pH of the Lime Mud restricts the support of vegetation. Grasses will be the most suitable stabilizing vegetation for the berm as they will grow in the clay cover layer, and will be only marginally affected by the Lime Mud.

In evaluating the options it was determined that the Hervo Site could utilize approximately 190,000m^3 of the stockpile, with the remainder being moved over time to the Brady Site.

Discussions with the City of Winnipeg (Mr. Darryl Drohomerski) were originally held to determine the parameters of the disposal option at a landfill. However, it was determined that the Brady Site has a need to develop sight line restriction berms around the perimeter of the

property. It was therefore agreed that rather than creating a cell specific to the disposal of the lime mud, that the material be utilized for the construction of the berms. This is estimated to easily utilize all the remaining stockpile (approximately 300,000 m^3) following the construction of the Hervo Site berms.

4.0 SITE LOCATION AND ZONING

Two separate sites will be utilized for purposes of disposal of the lime mud piles. The first site is called the "Hervo Site". The Site is bound to the south by Bishop Grandin Boulevard, to the east by the CN Letellier Rail Line, to the west by Waverley Road and to the north by the Lot 16 drainage ditch. According to the City of Winnipeg, Planning, Property and Development Department, the Site and adjacent properties are zoned for industrial use (M2 designation).
The second site is the Brady Landfill property "Brady Site" located just south of the perimeter highway (Highway 101). This is the primary waste disposal area for the City of Winnipeg. The Brady Site is bound to the north by the Perimeter Highway, the east by Waverley Street and the west by Brady Road. According to the City of Winnipeg, Planning, Property and Development Department, the Site and adjacent properties are zoned for Agricultural use (A designation).
A map showing the location of the two Sites in relation to the City of Winnipeg and the approximate placement of the berms is shown in Appendix A.

4.1 Proposed Berm Construction

The identified best use of the lime mud (see Section 3.0) is to construct berms that will utilize the product primarily as a fill material. The options available from the Bishop Grandin Lime Mud Remediation Plan Letter (AMEC 2013) indicate that the Lime Mud material can be utilized for fill inside of the berm itself, and that clay material to a depth of 0.5 to 1 meter should be installed over the fill. For the Hervo Site fill slopes, generally in the range of about 6:1 (H:V) to 8:1 (H:V), are proposed. For the Brady Road site, these will be designed as a 5 m wide crest with 3.86H:1V slopes. Slope stability assessments have confirmed this arrangement as viable for the Hervo Site, and preliminary analysis has been completed for the Brady Site.

The resulting berms will be stable and the clay material will serve to prevent erosion of the lime mud, which is quite fine grained. The capping will also provide an opportunity to utilize a number of vegetative coverings for aesthetic purposes. Deep rooted plants would need to be pH tolerant to establish and survive. It should be noted that the current lime mud piles are vegetated by ragweed during the summer months.

Figures in Appendix A show the conceptual structure of the berms from both the Hervo and Brady Sites.

5.0 OBJECTIVES

The purpose of the review was to identify actual or potential environmental concerns at the Sites related to the use of the Lime Mud stockpiles for landscaping. The review is expected to

be completed to a level that will allow regulators to assess the risk of the use of this material to the existing environment. Such an evaluation would normally involve the detailed review of existing information pertaining to conditions at the Site through an examination of known studies.
A number of related studies have been conducted as part of preliminary studies for the project in the area of the Lime Mud stockpiles. This review is intended to incorporate the findings of the previous reports, and in order to be effective should be viewed in conjunction with geotechnical evaluations (AMEC 2013), and any future landscape designs that may be produced for the Sites.

As part of review process, it is necessary to evaluate past and current studies at the Site and assess the possibility of the Lime Mud material impacting the Site if used for landscaping purposes. No new field investigations were undertaken as part of this review and it is based entirely on information found in existing reports. This review pertains mainly to the proposed construction of a berm along the southern boundary of the Hervo Site, although different uses are briefly introduced for purposes of comparison. After discussions with MCWS, it was agreed that the assessment will consist of a limited number of potential environmental items that were deemed pertinent to the review. (See Section 6.0 below).

6.0 METHODOLOGY

This review was conducted by collecting pertinent information related to the Lime Mud stockpiles at the Site, determining the potential pathways that would create environmental effects, and assessing the potential for any effects to actually occur.

This report was prepared in conjunction with information presented in a letter report dated December 20, 2013 from AMEC to Mr. Don Larke at Hopewell titled “Bishop Grandin Lime Mud Remediation Plan”. The AMEC letter report discusses the qualities of the Lime Mud stockpiles, and presents plans for the use of the material in landscaping and structural situations. The information is critical to this review, as it assists in determining the potential for environmental interactions, and the remediation activities to reduce or eliminate any negative effects.

During the review, many pertinent reports were found that contained information related to the Site. These are listed in Section 2.3.1. of this report.

Discussions pertaining to the Site were held with MCWS vin October, 2013. During these discussions, MCWS indicated that the primary interest would be related to:

- Potential for impacts to groundwater;
- Potential for impacts to surface water; and
- Potential for impacts to air quality (dust).

These discussions have guided this report in its focus on the above issues. It should be noted that previous investigative reports have been referenced by MC in their decision to focus on the listed issues.

7.0 SETTING OF THE SITES AND SURROUNDINGS

The project intends to utilize Lime Mud stockpiles located on the former Roger's Sugar factory property, and incorporate the material into landscape features on the Sites. The Hervo Site is located on the east side of Waverly Avenue and is is bound to the south by Bishop Grandin Boulevard, to the east by the CN Letellier Rail Line, to the west by Waverley Road and to the north by the Lot 16 drainage ditch. The surrounding land consisted of industrial properties to the north (Former Roger's Sugar property) and west (The Waverley Autopark, Murray Hydundai). The property to the east is bounded by the CN rail line, and the Manitoba Hydro Right of Way. Further to the east are apartment buildings located along Pembina Highway and some commercial developments and properties. Residential development is present further to the south (Richmond West) past Bishop Grandin Boulevard
The Brady Site is bound to the north by the Perimeter Highway, the east by Waverley Street and the west by Brady Road. The area is rural in nature, although substantial residential development is located to the north (Waverley West) and the east (Richmond West). There are a few rural residences further to the south and west of the Site, but the Site was selected in part due to its isolation from potential landowner conflicts. As previously mentioned, long term plans for the Brady Landfill include the eventual construction of barriers along the perimeter of the property for aesthetic purposes.

7.1 EXISTING SITE CONDITIONS

7.1.1 Surface Water, Topography and Drainage

Hervo Site

The lot 16 Drain, located along the northern boundary of the Site is the principal surface water feature in the area. This drain was formerly a natural creek that conveyed flows from the west to the Red River. Over the course of years, this creek has been channelized and converted to a drainage channel. The drain is linked to storm water ponds as far away as Kenaston Avenue (approximately 2.4 km west) and Waverley West (500 m south). The drain carries water to the east where it enters underground pipes that flow under Pembina Highway, and eventually discharge into the Red River (approximately 1 km east). Several ponds are associated adjacent to the Site along the drain.

In general, the Site itself is relatively flat lying. While overall drainage would be towards the Lot 16 Drain, the majority of the Site appeared to be poorly drained as evidenced by a number of small depressions and standing water.

Brady Site

The closet waterbodies to the Brady Site include the La Salle River, which is located approximately 1.5 km south east of the Site; the Westendorf Coulee, which is a tributary that

originates northeast of the Site and drains in an easterly to southeasterly direction; and municipal ditches located in the vicinity of the Site (Stantec, 2011).

Drainage from the Site is generally to the east and south to the La Salle River (Stantec, 2011)

Based on the EIA completed by Stantec (2011) is was determined that surface water at the landfill is typical of water found in the Red River Basin.

7.1.2 Site Geology and Groundwater

Hervo Site

Based on available geological maps, the subsurface stratigraphy in this area of the province normally consists of topsoil and fill materials underlain by glacio-lacustrine silt and clay to a depth of about 9 to 15 m from grade. A deposit of silty till, typically a number of metres thick, occurs between the clay and the underlying bedrock. The bedrock in this area consists of dolomite with limestone beds of variable thickness near the base and top of the subunit and is of the Upper Fort Garry member (Baracos et al., 1983). Bedrock is estimated to occur at about 18 to 24 m below grade. Detailed topography is presented in the 2013 AMEC letter referenced elsewhere in this report.

Fractured zones in the bedrock comprise the major aquifer in the area. There are no aquifers above the bedrock. Within the immediate vicinity of the Site, there were 4 groundwater wells, which were associated with former investigations by Wardrop (1997). None of these wells could be located and potential future use of the wells is not known. It is assumed that they will not be in use for potable water, as all areas nearby are serviced by City of Winnipeg water supply.

The groundwater in the area was noted in previous reports (Wardrop 1997) to have slightly elevated concentrations of some metals, although all results reported were within CCME guidelines. The continued presence of the Lime Mud is not expected to contribute to any ground water issues, and the capping of the berm with clay will reduce the potential for transport to the local aquifers.

Brady Site

Based on available geological maps, the subsurface stratigraphy in this area of the province normally consists of topsoil and fill materials underlain by glacio-lacustrine silt and clay to a depth of about 9 to 15 m from grade. A deposit of silty till, typically a number of metres thick, occurs between the clay and the underlying bedrock. The bedrock in this area consists of calcareous shale, with red and purple fossiliferous, thin limestone interbeds of the Gunn Member Formation. The depth to glacial till ranges from 41-50 feet and the depth to bedrock has not been determined (Baracos et al., 1983).

Site stratigraphy (Stantec, 2011) indicates that beneath the landfill glaciolacustrine clay can be found varying in thickness between 11 and 16 m with an average value of 13.8 m. In the upper

5-8 m weathered olive-brown clay is found and is called “brown clay”. The lower portion of the clay in the stratigraphic unit has grey color. A number of silt pockets and gypsum clusters have also been found in the clay. It was also found that the clay unit overlies a silty till of grey color whose thickness ranges from 1.5 to 13 metres (Stantec, 2011). Bedrock, white dolomitic limestone of the Red River Formation, was estimated to occur anywhere from 16 to 29 metres below the ground (Stantec, 2011)

Based on historical records (UMA, 1987) it was identified that the Brady Road Landfill is located above a carbonate aquifer producing non-potable groundwater. Fractured zones in the bedrock can be found at the Site in which an aquifer is present (Stantec, 2011). Again, the groundwater was determined to be non-potable due to high salinity values.

Groundwater is monitored by the City of Winnipeg at least twice a year (Stantec, 2011). Results of the EIA prepared by Stantec for the Brady Road Landfill and Future Resources Management Facility concluded that there were no significant adverse effects from almost four decades of the landfill operations that can be discerned from the analysis of publicly available data describing community health, air quality and groundwater quality. Based on these findings it is assumed that disposal of the Lime Mud at the Brady Road Landfill as well as the creation of berms will have no negative impacts on groundwater.

7.1.3 Air Quality

Air quality is not significantly discussed in available reports. However, it should be noted that the main concern is related to wind borne dust coming from Lime Mud piles. Lime mud is a very fine grained product, and when dry is susceptible to wind erosion (AMEC 2012). This is of some concern to the construction of a berm along Bishop Grandin Boulevard (Hervo Site) due to the heavy traffic along the route, and raises the potential for reduced visibility in high winds for traffic. The main concern will be during the construction period. There is also the same concern along Waverley Boulevard and Brady Road (Brady Site), although traffic volumes are considerably lighter with lower speed limits. There is also the issue of transporting 300,000 m^3 of lime mud to the Brady Site for the construction of berms. This will be done utilizing trucks and will take place over a number of years.

It will be necessary to ensure that the lime mud is kept in check through BMPs that will include proper truck transport protocols to reduce any potential for dust, watering, restrictions to high wind events and height of stockpiles near all roads. Once the berms are capped with clay, this problem will be eliminated, particularly after vegetation establishes.

8.0 POTENTIAL ENVIRONMENTAL EFFECTS

The use of the lime mud for the construction of berms appears to be the best use for disposal of the product in order to remediate the existing storage location. Constructing berms will provide both functional and aesthetic benefits.

Based on the review undertaken, there is potential for minor impacts as a result of the use of the Lime Mud. It is expected that these impacts will be minimal as follows:

8.1 Impacts to Surface Water

The main potential impact to surface water at the Hervo Site from the project is to increase sediment loads in the Red River. However, the Red River already is very high in both TSS values (25 to 86 ppm) according to Manitoba Conservation (2002). Any additions from the project will be undetectable once BMPs are followed and the berm is capped with clay. Likewise the potential to alter pH of the River Water is unlikely. Manitoba Conservation (2002) reports that Red River pH within the City of Winnipeg is between 7.9 and 8.3, which is similar to the Lime Mud. Any changes will be undetectable.

For the Brady Site, the EIA prepared by Stantec (2011) determined that the chemistry of the surface water currently being discharged from the Brady Road Landfill is typical of waters found in the Red River Basin. No elevated concentrations of inorganic contaminants were found in the runoff from the Site and that chemical characteristics of the runoff are generally within the baseline conditions found downstream in the La Salle River. The main potential impact to surface water from the project is the increase of sediment loads in the surrounding municipal drains and Westendorf Coulee.

During construction it will be necessary to follow Best Management Practices (BMPs) to reduce the potential for sediment to enter surface waters. This would be accomplished through the use of silt fences, and drainage management. This will effectively mitigate any potential for erosion once the structure is completed. Any additions from the project will be negligible once BMPs are followed and the berm is capped with clay.

There is some potential for erosion activities to cause sediments from the lime mud pile to enter the lot 16 Drain, and from there enter the Red River. Sediment deposition is seen as an environmental impact. Potential is greatest during the construction period. During construction it will be necessary to follow Best Management Practices (BMPs) to reduce the potential for sediment to enter surface waters. This would be accomplished through the use of silt fences, and drainage management. The options available from the Bishop Grandin Lime Mud Remediation Plan Letter (2013) indicate that the lime mud material will be utilized for fill inside of the berm itself, and that clay material to a depth of 1 meter will be installed over the fill at a 6:1 slope. This will effectively mitigate any potential for erosion once the structure is completed.

There is some potential for erosion activities to cause sediments from the Lime Mud pile to enter surrounding municipal drains, and from there enter the Red River. Sediment deposition is also possible for the Westendorf Coulee. The potential for deposition is greatest during the construction period.

8.2 Impacts to Ground Water

As noted in the Wardrop reports (1993, 1997) there is some detection of groundwater impacts in the area of the Hervo Site. However, these are not the result of the Lime Mud, but rather are

ancillary to the operation of the former plant, and a number of anthropogenic effects in the area. The fact that ground water is not utilized for consumption in the area, and the low permeability of the soils (AMEC 2013) indicates that no effects would be detected once the Lime Mud is capped with clay.

The fact that ground water is not utilized for consumption in the area indicates there will be no ingestion pathway. The low permeability of the soils (AMEC 2013) indicates that effects from using the Lime Mud in a clay capped berm would be negligible.

8.3 Impacts to Air Quality (Dust)

The only potential impact to air quality is from dust. This is especially important due to the location of the proposed berm along Bishop Grandin Boulevard. However, BMPs can effectively reduce or eliminate the potential for effects during construction, and once capped any potential effects will be eliminated.

From the above, it is probable that any use of the Lime Mud for construction of the berm will not present an environmental concern, as long as BMPs are followed during construction and transportation, and the final product is capped with a clay cover. Some restrictions to future vegetation along the berm are expected and may limit aesthetic remediation.

9.0 Time Frame

The project for the complete removal of the lime mud piles is expected to be spread out over several years. The first phase of the project will be to complete the berm along Bishop Grandin Boulevard. Work on this is expected to begin in 2014 with a completion date to be determined based on contractor input.

The second phase of building the berms around the Brady Site is expected to begin following completion of final design and geotechnical studies. It is not expected that this would start in 2014, and would take place for a number of years depending on contractor inputs and availability.

9.1 Report Review

AMEC reviewed the following reports:

- 1992 Geotechnical Investigation Volume I, Manitoba Hydro Waverley Service Centre, Winnipeg, Manitoba prepared by Manitoba Hydro Geotechnical Department. February 1993.
- Phase I Environmental Site Assessment, Waverley Service Centre Lot 2 Lands, Winnipeg, Manitoba prepared by TetrES Consultants Inc. September 1995.

- Phase I Environmental Site Audit Update, Lot 2, Waverley Service Centre, Winnipeg, Manitoba prepared by Wardrop Engineering Inc. June 1997.
- Phase I Environmental Site Assessment, Sugar Refinery, Winnipeg, Manitoba prepared by Wardrop Engineering Inc. July 1997.
- Phase II Environmental Site Assessment, Former Rogers Sugar Factory, Winnipeg, Manitoba prepared by Wardrop Engineering Inc. 1997.
- Additional Environmental Investigations, Former Rogers Sugar Factory, Winnipeg, Manitoba prepared by Wardrop Engineering Inc. August 1999.
- The Red River and Lake Winnipeg Water Quality. Nicole Armstrong and Dwight Williamson. Water Quality Management Section. Water Branch. November 2002. Manitoba Conservation Report No. 2002-09.
- Phase I Environmental Site Assessment, Proposed Commercial Development Manitoba Hydro and CP Rail Easements, Winnipeg, Manitoba, Prepared by AMEC, September 2005.
- Preliminary Geotechnical and Environmental Investigation Proposed Commercial Development Former Roger's Sugar Property, Winnipeg Manitoba, Prepared by AMEC September, 2005
- Results of Lime Mud Testing and Analysis, 555 Hervo Street, Winnipeg Manitoba. Letter report to Mr. Ron Herron from AMEC, March 16, 2007.
- Lime Mud Evaluation, 555 Hervo Street, Winnipeg, Manitoba. Letter Report to Mr. Shauna Kvellestad, Hopewell Development Corporation from AMEC. February 21, 2012.
- Bishop Grandin Lime Mud Remediation Plan. Letter Report to Mr. Don Larke, Hopewell Development Corporation from AMEC, December 2013.
- Hopewell-Hervo Stability Assessment for Berm Construction. Letter Report to Mr. Don Larke, Hopewell Development Corporation from AMEC, December 2013.
- Environmental Impact Assessment of the Brady Road Landfill and Future Resources Management Facility. 2011. Prepared by Stantec.
- UMA Engineering Ltd. 1987. Brady Road Landfill Hydrogeologic Study Report. Prepared for the City of Winnipeg, August 1987. Winnipeg, Manitoba

In addition, the following regulatory guideline was reviewed:

- Manitoba Surface Water Quality Standards, Objectives and Guidelines. Manitoba Water Stewardship report 2011-01.

10.0 CLOSURE

This report has been prepared for the exclusive use of the Hopewell Development Corporation and their agents for specific application to the subject Site. The review was conducted entirely based on information contained in reports by various authors over a number of years, and as such is subject to the accuracy of the information in those reports. No other warranty, expressed or implied, is made.

APPENDIX A

FIGURES

LEGEND:

- CONTOURS
- PROPOSED FILL CONTOUR LINE
- BOUNDARY LINES
- ROAD
- RAILS

CLIENT LOGO

CLIENT: HOPEWELL DEVELOPMENT CORPORATION

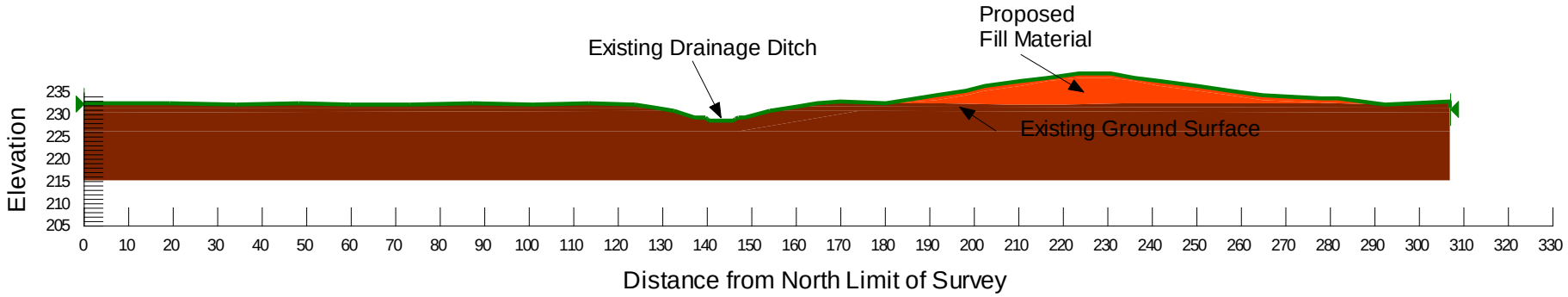
AMEC Environment & Infrastructure
440 DOVERCOURT DRIVE
WINNIPEG, MANITOBA R3Y 1N4
PHONE: 204.488.2997 FAX:204.489.8261

DWN BY:	MD
CHK'D BY:	XXX
DATUM:	NAD83
PROJECTION:	UTM Zone 14 U
SCALE:	AS SHOWN

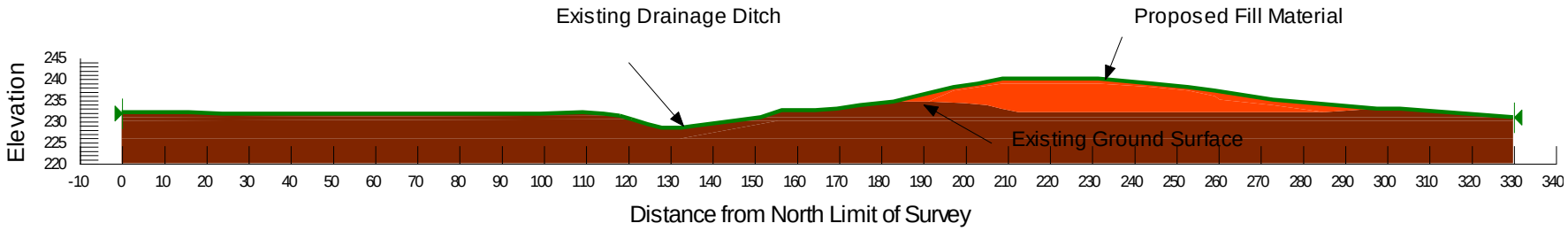
GEOTECHNICAL ASSESSMENT
PROPOSED LIME MUD PLACEMENT PLAN
NEAR WAVERLEY AT BISHOP GRANDIN
WINNIPEG, MANITOBA

SITE PLAN

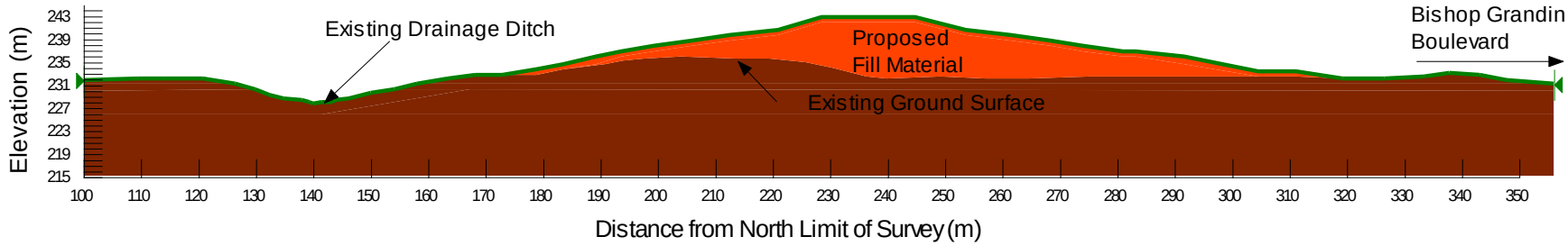
DATE:	DECEMBER 2013
PROJECT NO:	WX17301
REV. NO.:	A
FIGURE No.	1



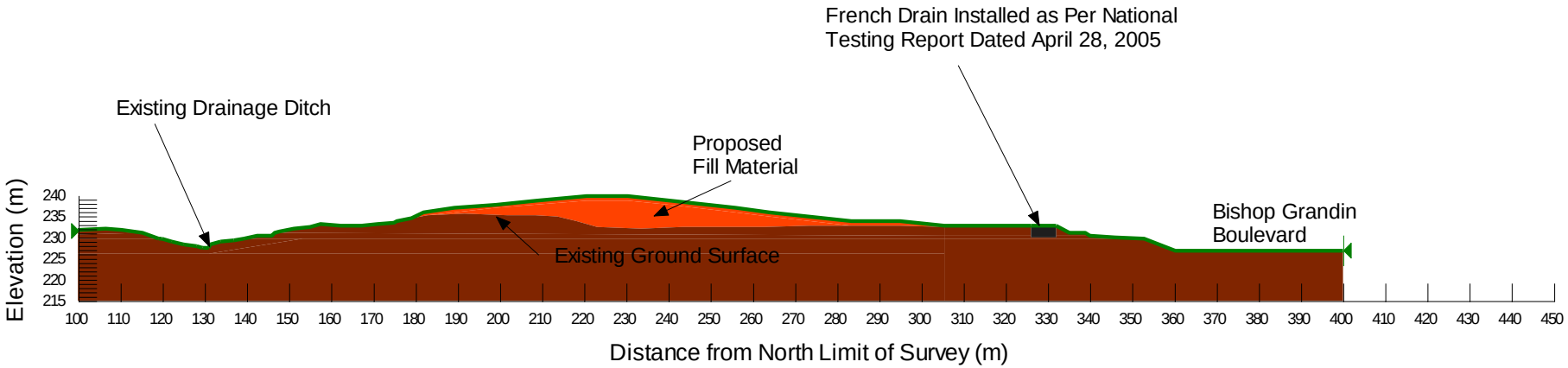
amec *Environment and Infrastructure* *A Division of AMEC Americas Limited*		**Hopewell Development Corporation**			**PROPOSED ROGERS SUGAR BEET LIME-MUD PLACEMENT – BISHOP GRANDIN BOULEVARD** **CROSS SECTION A-A**
Drawn by: JW	Scale: NA	Date: Dec/13	Proj. No: WX17301	Figure: 2	**EXISTING GROUND SURFACE AND PROPOSED FILL**



amec *Environment and Infrastructure* *A Division of AMEC Americas Limited*		**Hopewell Development Corporation**			**PROPOSED ROGERS SUGAR BEET LIME-MUD PLACEMENT – BISHOP GRANDIN BOULEVARD** **CROSS SECTION B-B**
Drawn by: JW	Scale: NA	Date: Dec/13	Proj. No: WX17301	Figure: 3	**EXISTING GROUND SURFACE AND PROPOSED FILL**

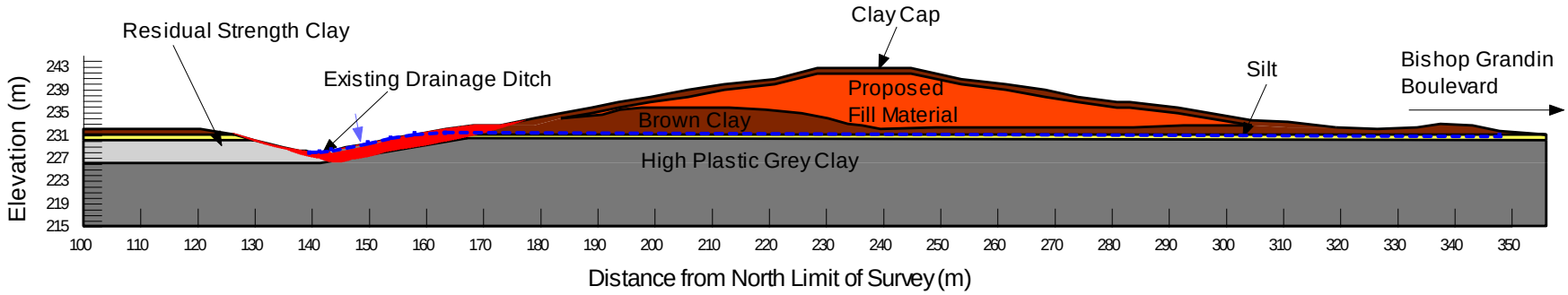


amec *Environment and Infrastructure* *A Division of AMEC Americas Limited*		**Hopewell Development Corporation**			**PROPOSED ROGERS SUGAR BEET LIME-MUD PLACEMENT – BISHOP GRANDIN BOULEVARD** **CROSS SECTION C-C** **EXISTING GROUND SURFACE AND PROPOSED FILL**
Drawn by: JW	Scale: NA	Date: Dec/13	Proj. No: WX17301	Figure: 4	



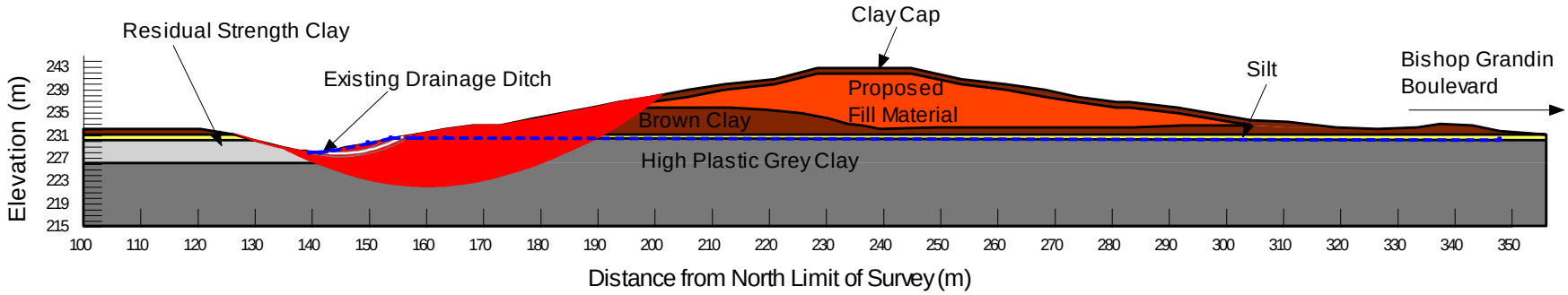
Environment and Infrastructure *A Division of AMEC Americas Limited*		**Hopewell Development Corporation**			**PROPOSED ROGERS SUGAR BEET LIME-MUD PLACEMENT – BISHOP GRANDIN BOULEVARD** **CROSS SECTION D-D** **EXISTING GROUND SURFACE AND PROPOSED FILL**
Drawn by: JW	Scale: NA	Date: Dec/13	Proj. No: WX17301	Figure: 5	

Brown Clay: Unit Weight = 18 kN/m3, cohesion = 4 kPa, Phi = 15 degrees
Silt: Unit Weight = 18 kN/m3, cohesion = 0 kPa, Phi = 22 degrees
Residual Strength Clay: Unit Weight = 18 kN/m3, cohesion = 0 kPa, Phi = 10 degrees
High Plastic Grey Clay: Unit Weight = 18 kN/m3, cohesion = 4 kPa, Phi = 15 degrees
Proposed Fill Material: Unit Weight = 18 kN/m3, cohesion = 0 kPa, Phi = 25 degrees



amec *Environment and Infrastructure* *A Division of AMEC Americas Limited*		**Hopewell Development Corporation**		**PROPOSED ROGERS SUGAR BEET LIME-MUD PLACEMENT – BISHOP GRANDIN BOULEVARD** **CROSS SECTION C-C – DITCH SIDE** **WORST CASE GROUNDWATER CONDITIONS** **FACTORS OF SAFETY MAP FOR 1.3 OR LESS**
Drawn by: JW	Scale: NA	Date: Dec/13	Proj. No: WX17301	Figure: 6

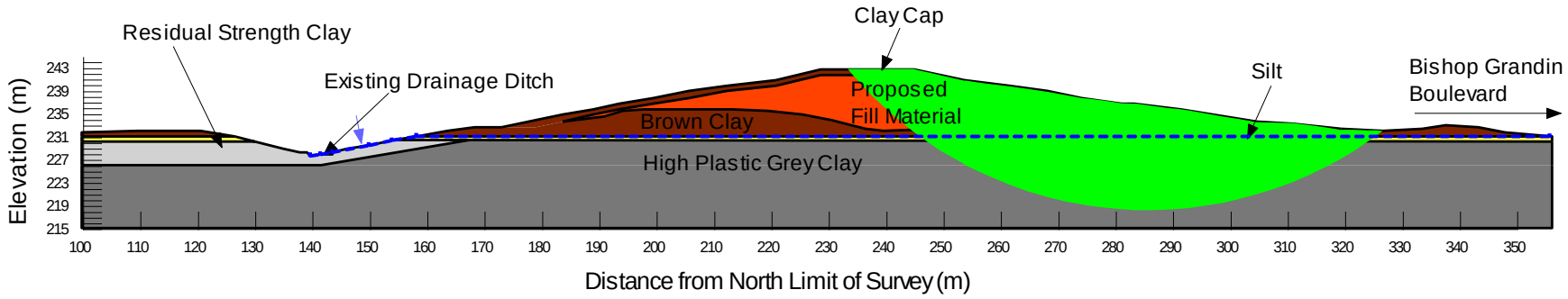
Brown Clay: Unit Weight = 18 kN/m3, cohesion = 4 kPa, Phi = 15 degrees
Silt: Unit Weight = 18 kN/m3, cohesion = 0 kPa, Phi = 22 degrees
Residual Strength Clay: Unit Weight = 18 kN/m3, cohesion = 0 kPa, Phi = 10 degrees
High Plastic Grey Clay: Unit Weight = 18 kN/m3, cohesion = 4 kPa, Phi = 15 degrees
Proposed Fill Material: Unit Weight = 18 kN/m3, cohesion = 0 kPa, Phi = 25 degrees



Environment and Infrastructure *A Division of AMEC Americas Limited*		**Hopewell Development Corporation**		**PROPOSED ROGERS SUGAR BEET LIME-MUD PLACEMENT – BISHOP GRANDIN BOULEVARD** **CROSS SECTION C-C – DITCH SIDE** **NORMAL CASE GROUNDWATER CONDITIONS** **FACTORS OF SAFETY MAP FOR 1.5 OR LESS**
Drawn by: JW	Scale: NA	Date: Dec/13	Proj. No: WX17301	Figure: 7

Brown Clay: Unit Weight = 18 kN/m3, cohesion = 4 kPa, Phi = 15 degrees
Silt: Unit Weight = 18 kN/m3, cohesion = 0 kPa, Phi = 22 degrees
Residual Strength Clay: Unit Weight = 18 kN/m3, cohesion = 0 kPa, Phi = 10 degrees
High Plastic Grey Clay: Unit Weight = 18 kN/m3, cohesion = 4 kPa, Phi = 15 degrees
Proposed Fill Material: Unit Weight = 18 kN/m3, cohesion = 0 kPa, Phi = 25 degrees

○ FOS 2.16



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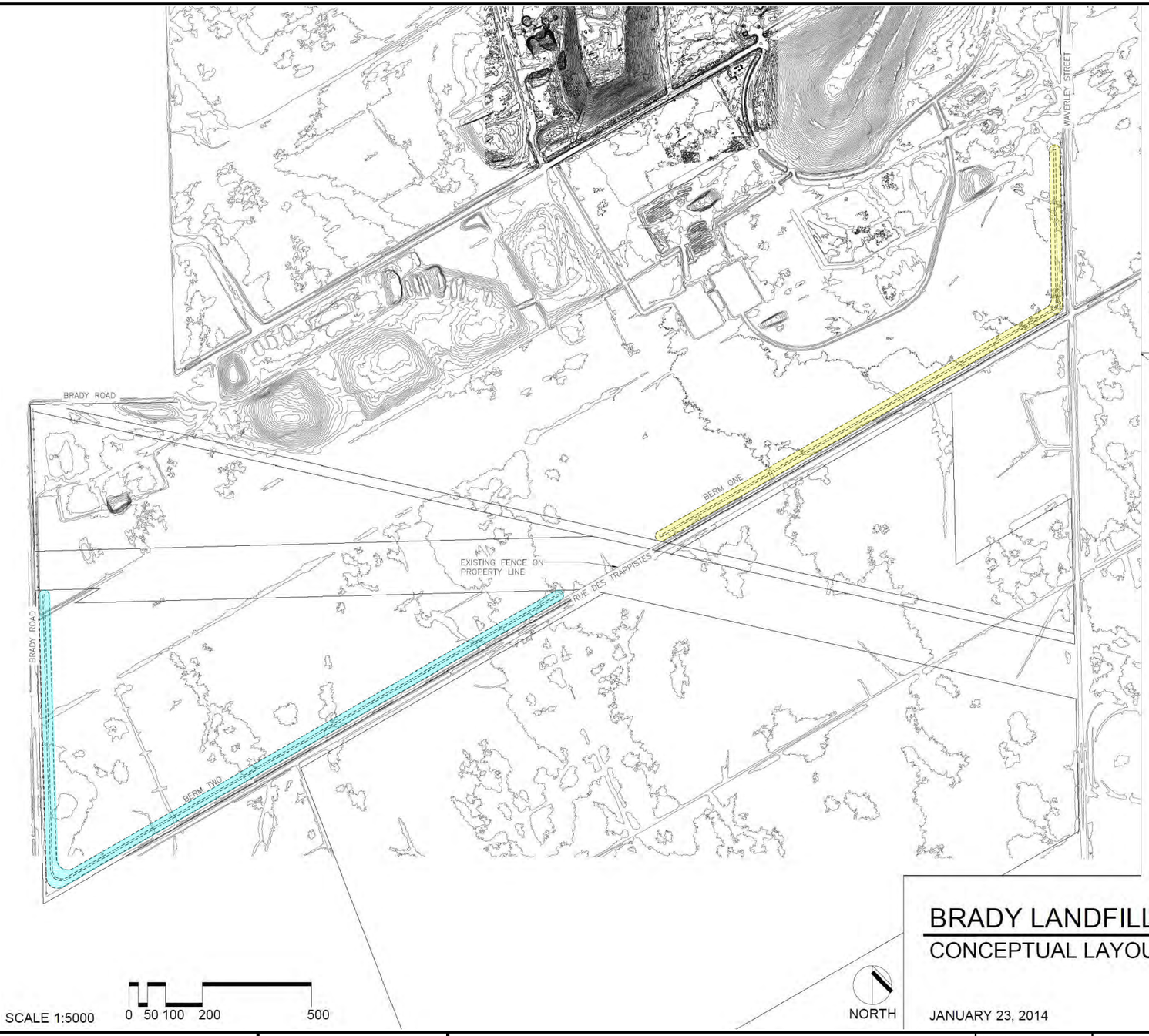
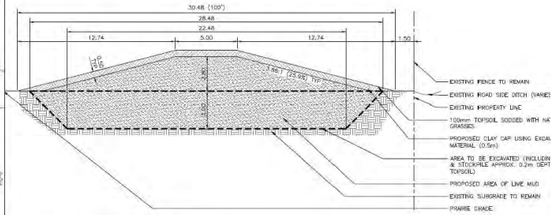
Drawn by: JW	Scale: NA	Date: Dec/13	Proj. No: WX17301	Figure: 8	





CONCEPTUAL CROSS SECTION

BRADY LANDFILL LIME MUD BERM

CONCEPTUAL LAYOUT PLAN & CROSS SECTIONS

JANUARY 23, 2014

McGOWAN·RUSSELL

LEGEND:

- BERM ONE
- BERM TWO

CLIENT LOGO

CLIENT: HOPEWELL DEVELOPMENT CORPORATION

AMEC Environment & Infrastructure
440 DOVERCOURT DRIVE
WINNIPEG, MANITOBA R3Y 1N4
PHONE: 204.488.2997 FAX:204.489.8261

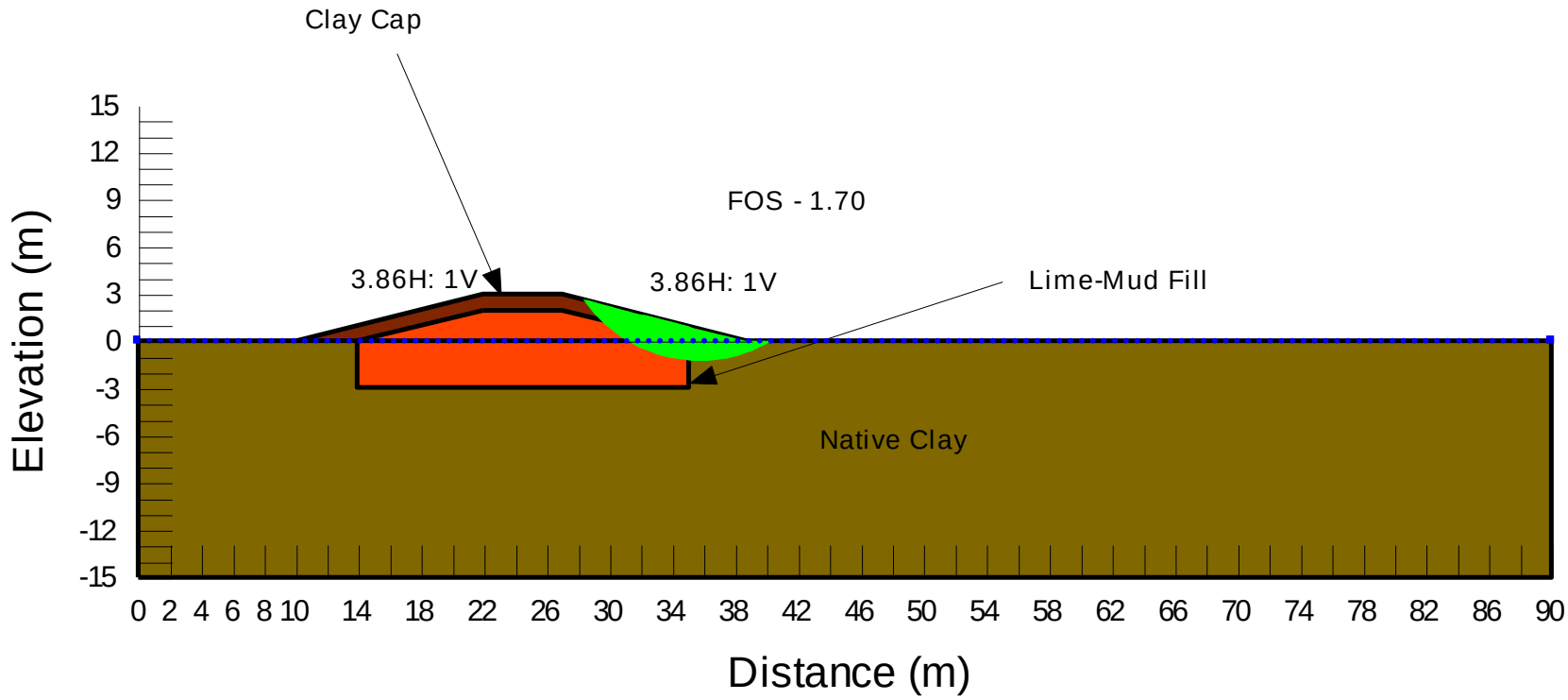
DWN BY:	MD
CHK'D BY:	TG
DATUM:	NAD83
PROJECTION:	UTM Zone 14 U
SCALE:	AS SHOWN

GEOTECHNICAL ASSESSMENT
PROPOSED LIME MUD PLACEMENT PLAN
NEAR WAVERLEY AT BISHOP GRANDIN
WINNIPEG, MANITOBA

CONCEPTUAL LAYOUT PLAN AND CROSS SECTION

DATE:	FEBRUARY 2014
PROJECT NO:	WX17301
REV. NO.:	A
FIGURE No.	1

P:\Jobs\17300's\17300's\17301 – Hopewell – Hervo – Slope Assessment\Drawings\WX17301.dwg – F1 (2) – Feb. 07, 2014 8:26am – matthews.dolores



Brown Clay: Unit Weight = 18 kN/m3, cohesion = 4 kPa, Phi = 15 degrees degrees
Proposed Fill Material: Unit Weight = 18 kN/m3, cohesion = 0 kPa, Phi = 25 degrees

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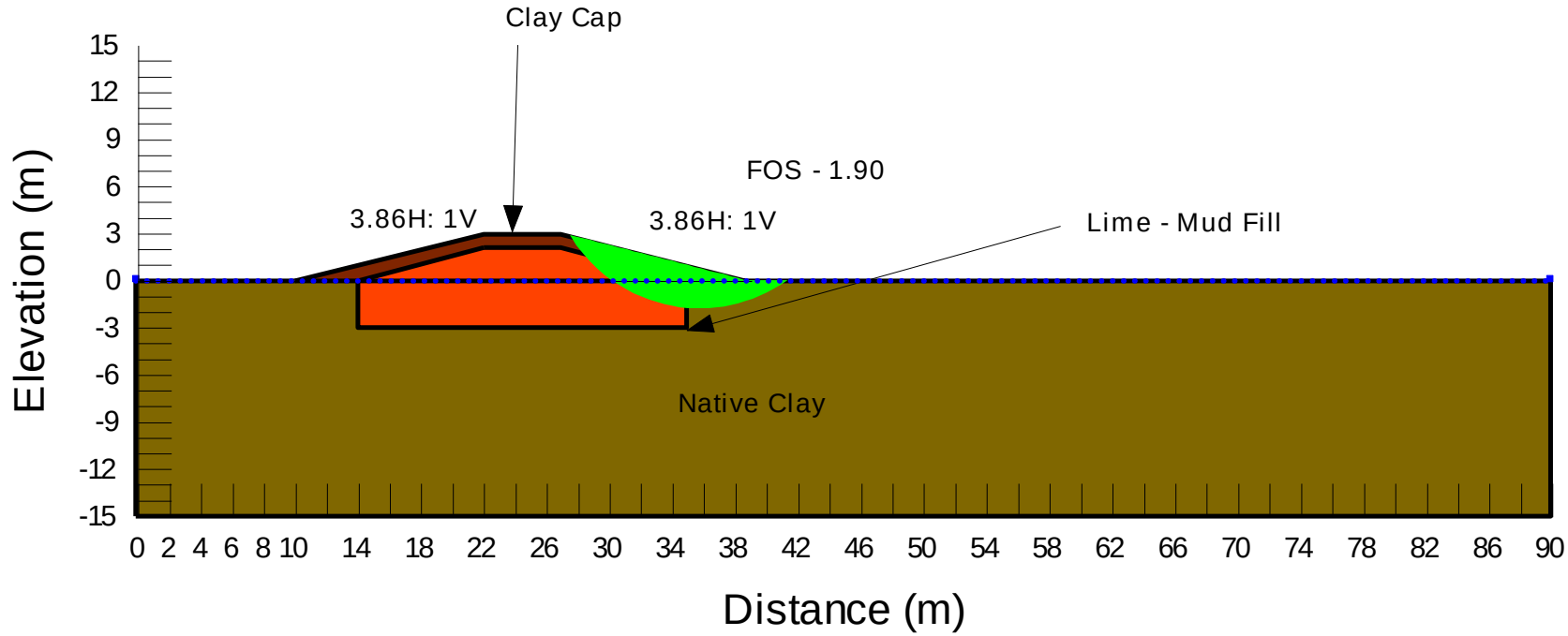
Drawn by: JW	Scale: NA	Date: Feb/14	Proj. No: WX17301	Figure: 2	



Brown Clay: Unit Weight = 18 kN/m3, cohesion = 4 kPa, Phi = 15 degrees
Proposed Fill Material: Unit Weight = 18 kN/m3, cohesion = 0 kPa, Phi = 25 degrees

amec *Environment and Infrastructure* *A Division of AMEC Americas Limited*		**Hopewell Development Corporation**			**PROPOSED ROGERS SUGAR BEET LIME-MUD PLACEMENT – BRADY ROAD LANDFILL** **PROPOSED 3.86H:1V BERM SLOPE STABILITY LONG TERM CONDITIONS**
Drawn by: JW	Scale: NA	Date: Feb/14	Proj. No: WX17301	Figure: 3	

APPENDIX B
LIME MUD LABORATORY ANALYSIS RESULTS

TABLE 1: LABORATORY ANALYSIS – ICP METALS - SOIL												
Parameter	**TP1 @ 0.9 -1.1 m**	**TP3 @ 3.5 -3.7 m**	**TP4 @ 1.2 m**	**TP5 @ 4.0 m**	**TP6 @ 2.4 -2.7 m**	**TH1 @ 4.3 m**	**TH2 @ 9.0 m**	**TH12 @ 6 m**	**TH13 @ 1.5 m**	**TH14 @ 0.3 m**	**TH15 @ 0.8 m**	**CCME EQG Commercial**
Arsenic	2.28	3.45	1.37	4.33	1.03	0.91	0.86	1.41	1.65	1.6	0.94	12
Barium	93.3	80.0	36.3	256	24.2	26.7	19.0	27.7	30.0	30.2	18.2	2000
Beryllium	0.5	0.24	0.22	0.27	0.11	0.10	0.14	0.20	0.24	0.17	0.13	8
Bismuth	0.12	0.08	<0.02	0.06	<0.02	<0.02	<0.02	0.03	0.03	0.03	<0.02	NG
Cadmium	0.13	0.17	0.25	0.42	0.37	0.27	0.39	0.25	0.32	0.30	0.31	22
Chromium	22.1	12.1	5.0	12.1	7.6	7.6	5.4	7.5	6.8	7.5	4.3	87
Cobalt	6.47	4.26	1.05	3.11	0.81	0.71	0.83	1.37	1.31	1.31	0.87	300
Copper	18.3	12.0	19.5	40.0	23.5	32.6	31.4	34.8	38.3	26.6	19.4	91
Lead	8.18	4.45	1.86	12.5	3.22	1.69	1.44	2.18	1.97	2.32	1.46	260
Molybdenum	0.38	0.22	0.15	0.36	0.13	0.12	0.13	0.16	0.17	0.21	0.10	40
Nickel	21.7	15.8	10.6	14.5	12.5	10.6	11.7	10.7	13.1	12.9	12.4	50
Selenium	0.1	0.2	0.3	0.4	0.4	1.7	0.5	0.3	0.3	0.3	0.2	3.9
Silver	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	40
Strontium	43.3	91.7	121	135	101	111	91.3	82.4	94.9	85.7	95.1	NG
Thallium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	1
Tin	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	300
Uranium	0.56	0.68	0.56	1.05	0.79	0.84	0.47	0.52	0.55	0.58	0.48	NG
Vanadium	21.1	26.6	6.90	14.8	6.28	4.45	5.14	8.38	8.38	8.23	4.62	130
Zinc	56	26	37	66	36	40	29	37	43	34	35	360

TABLE 2: LABORATORY ANALYSIS – ICP METALS - SOIL												
Parameter	**TP1 @ 0.9 -1.1 m**	**TP3 @ 3.5 -3.7 m**	**TP4 @ 1.2 m**	**TP5 @ 4.0 m**	**TP6 @ 2.4 -2.7 m**	**TH1 @ 4.3 m**	**TH2 @ 9.0 m**	**TH12 @ 6 m**	**TH13 @ 1.5 m**	**TH14 @ 0.3 m**	**TH15 @ 0.8 m**	**CCME EQG Commercial**
pH	**8.70**	**8.82**	**8.78**	**8.95**	**9.07**	**9.02**	**9.22**	**9.39**	**8.56**	**8.88**	**9.16**	6 to 8

TABLE 3: SOIL LABORATORY RESULTS – PAHs		
Parameter	**Test Hole/Depth**	**CCME EQG Guideline Criteria**
	TP2 @ 3.0 m	**Commercial**
Acenaphthene	<0.01	NG
Acenaphthylene	<0.01	NG
Acridine	<0.05	NG
Anthracene	<0.01	NG
Benzo(a)anthracene	<0.01	10
Benzo(a)pyrene	<0.01	0.7
Benzo(b)fluoranthene	<0.01	10
Benzo(k)fluoranthene	<0.01	10
Benzo(g,h,I)perylene	<0.01	NG
Chrysene	<0.01	NG
Dibenzo(a,h)anthracene	<0.01	10
Fluoranthene	<0.01	NG
Fluorene	<0.01	NG
Indeno(1,2,3-cd)pyrene	<0.01	10
Naphthalene	<0.01	22
1-methylnaphthalene	<0.01	NG
2-methylnaphthalene	<0.01	10
Phenanthrene	<0.01	50
Pyrene	<0.01	100
Quinoline	<0.05	NG