TOTAL ENERGY SERVICES, INC.
INDUSTRIAL PARK SW-28-39-27-W.4
STORMWATER MANAGEMENT PLAN

Prepared for:
Total Energy Services, Inc

Prepared by:
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Red Deer, Alberta T4N 1X7

Project Number: 112849297-07

November 28, 2012

Table of Contents

Appendices

List of Figures

List of Tables

1.0 Site Description

1.1 INTRODUCTION

Total Energy Services Inc. has retained Stantec Consulting Ltd. to prepare a Stormwater Management Plan for the proposed industrial development. The TES Development is located approximately 14 km North of the City of Red Deer, and the proposed industrial development is located within the County of Lacombe. Please see Figure 1.0 Location Plan, on the following page. The proposed industrial development is located in the Southwest 1/4 Section 28, Range 39, Township 27, W4M.

The objective of this study is to demonstrate that the proposed stormwater management facility will meet Alberta Environment (AENV) criteria for permissible release rate and water quality improvements. It will also outline the proposed configuration for minor and major drainage systems within the industrial development.

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Client/Project
TES
Industrial Park
Lacombe County

Figure No.
1.0

Title
LOCATION PLAN

2.0 Existing Conditions

The majority of the area proposed for development is currently used for farming operations that include crop and hay production. There currently exists a farmstead in the south central region of the quarter section that is outside the project limits. The site contains a number of wetland areas which have been identified and a separate assessment has been completed by Stantec Consulting Ltd. for Total Energy Services Inc. These wetlands have been identified on Figure 2.0 Existing Conditions, on the following page. These identifications are based on the TES Industrial Development Wetland Assessment report dated November, 2011.

The existing ground for the majority of the site gently slopes at approximately 1 - 2% from the center of the site split to the north and south. The site has a high point elevation of ~888 m. The site also slopes at approximately 12-15% from various ridgelines down to the existing wetlands at a low point elevation of ~878.3 in Wetland 2 and ~ 877.3 in Wetland 3.

The site lies directly east of Range Road 274 and north of Aspelund Road. The site is bordered by undeveloped farmland on the western and northern boundary. The existing Aspelund Industrial development is located in the quarter section east of the site.

Wetland 3 is a large natural occurring wetland that continues north through three quarter sections, which drains eastward across Highway 2 and is ultimately linked to Lacombe Lake.

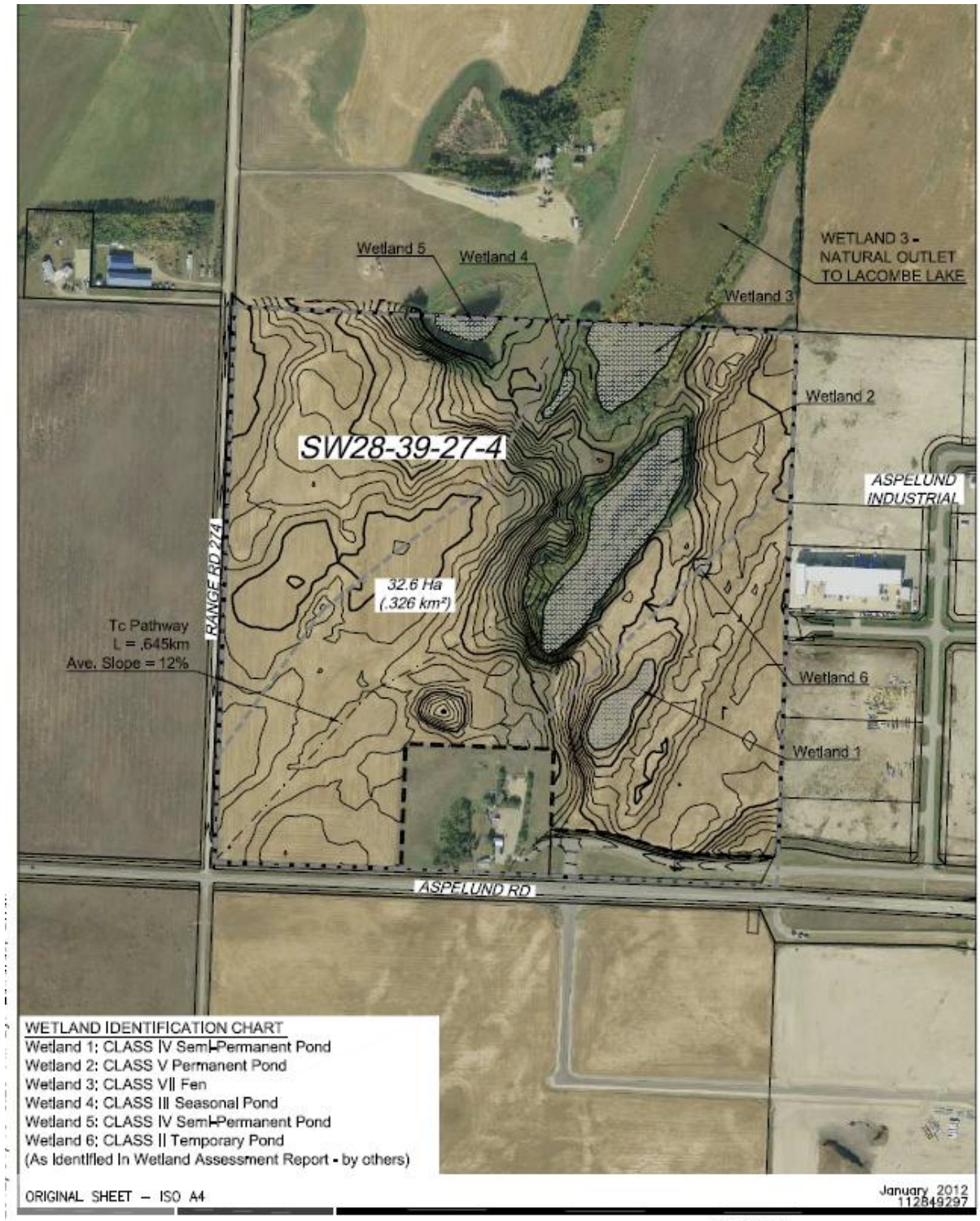

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Figure No.
2.0

Title
EXISITNG CONDITIONS

bk

3.0 Methodology and Input Data

3.1 COMPUTER MODEL

The Stormwater Management Hydrologic Model, commonly referred to as SWMHYMO (Version 4.02) was used in this study to perform single event analysis. By providing input data on rainfall and land use, the SWMHYMO model can be used to generate runoff for specific sub-catchments. Algorithms in SWMHYMO can then be used to model the conveyance of runoff through pipes or in open channels, and reservoir routing can also be done to represent the attenuating effects of storage found in traplows or stormwater management facilities.

The SWMHYMO User's Manual (J.F. Sabourin, 1999) provides a detailed description of the model structure and input data requirements.

Single event analysis performs hydrologic calculations for a single storm event utilizing actual historical precipitation data for the study area. Hourly precipitation data recorded at the Red Deer Airport for the time period from 1964 to 2006 was used for the single event analyse contained within this report. The rain gauge at the Red Deer Airport is not heated; therefore, only the hourly rainfall from April to October is available for most years within the period of record.

3.2 PRE-DEVELOPMENT FLOWS

Pre-development flow rates were estimated by using the rational method and confirmed using SYMHYMO. The Rational Method is based on an empirical formula relating the peak flow rate to the drainage area, the rainfall intensity, and a runoff coefficient. The rational method is the most common used method of predicting peak runoff rates for the design of urban systems.

The rational method for metric units is:

$$Q = 0.0028 * C * i * A \ (m/s^3)$$

Where Q is the peak flow rate, C is the runoff coefficient, i is the rainfall intensity (mm/hr) for a storm of duration equal to t_c, A is the effective area of the drainage basin (hectacres), and t_c is the time of concentration for the basin particular event (min).

It was assumed the wetland to be used as the discharge point has enough capacity to hold runoff from a 1:100 year storm event for its contributing drainage area. This being the case a time of concentration of 24 hours was used to determine the pre-development flow rate. As shown by the Bransby Williams Formula time of concentration calculations later in this section, this is a conservate assumption, limiting the actual pre-exisitng release rate (in other words, if anything the stormwater management facility is oversized).

The following parameters were used to determine the peak flow rate of the site. The total contributing onsite area to the wetland proposed to be used as the discharge point for the site is approximately 32.6 Ha. Of this 32.6 Ha, 3.9 Ha are currently holding water on a permanent basis and was taken to be completely impervious having a runoff coefficient of 1.0. The remaining 28.7 Ha is undeveloped area.

From Table 4-4 Selected Runoff Coefficients and Percent Impervious from the Alberta Environment Stormwater Management Guidelines, undeveloped areas are to have the same runoff coefficient as lawns. From experience working in the Blackfald's area, the surrounding land is predominantly sandy soils. Therefore lawns, sandy soil was used in determining a weighted runoff coefficient. The table lists the 1:100 year runoff coefficient as 0.2.

A weighted runoff coefficient was calculated was follows:

$$C = (3.9\ Ha * 1.0) + (28.7\ Ha * 0.2) / 32.6\ Ha = \mathbf{.3}$$

The SWMHYMO single event modeling, found in Appendix A, shows the total precipitation for a 1:100 year 24 hour storm to be 108.3 mm. This over the 24 hour period yields an average rainfall intensity of 5 mm/hr.

Therefore the predevelopment flow for the site can be estimated as follows:

$$Q_{pretotal} = 0.0028 * 0.3 * 5 * 32.6 = 0.13\ (m/s^3) = 130\ L/s$$

The total flow taken over the contributing drainage area yields a pre-development flow rate of:

$$Q_{rate} = 130\ L/s / 32.6\ Ha = 4\ L/s/Ha$$

To verify this release rate SYMHYMO was used to model a hydrograph for the existing drainage basin to wetland 3. The program was used to create a hydrograph based on Nash's synthetic instantaneous unit hydrograph, which views the watershed as a series of linear storage reservoirs. The hydrograph takes into account various parameters such as dry weather flow (assumed as zero), initial abstraction, time to peak, catchment area, and rainfall data.

A CN number of 74 was used based on farmstead cover type and hydrologic soil group B. The catchment area is the same used in the rational method, 32.6 Ha. Initial abstraction was estimated at 1.6 based on average values found in the SYMHYMO user manual. Time to peak was taken as $0.6T_c$ was recommended in the SYMHYMO user manual. Time of concentration was estimated based on the Bransby Williams Formula:

$$T_c = 0.605L / S^{0.2} * A^{0.1}$$

Where L is the gross length of the main channel (km), S is the net slope of said channel, and A is the watershed area (km^2). A T_c of 0.67 hr to wetland 1 and a T_c of 20 hr to wetland 3 was estimated. This equates to a total time of concentration of 20.67 hrs, giving a time to peak of 12.4 hours. As seen in Appendix A, this gives a peak flow of 0.141 cms equaling 4.3 L/s/ha.

Based on the results of the rational method calculated above and the SYMHYMO model, a pre-development release rate of 4 L/s/ha is assumed. Ideally, this is the rate that the site should discharge at to ensure that downstream drainage courses are not adversely affected. Discharging at a rate higher than this could potentially result in erosion and\or degradation of aquatic habitats. To help mitigate flooding downstream, a realease rate of 3.1 L/s/ha will be used. This is close to the anticipated area release rate for the Wolf Creek Basin.

Providing Discharge Rate Control down to 3.1 L/s/ha is typically met through the use of storm water management facilities. The storm water management facility would have a permissible release rate of 3.1 L/s/ha. However, it should be noted that even with the implementation of storm water management facilities (Discharge Rate Control) that the total runoff volume over time from a developed area would still be greater than for pre-development conditions. Given that the proportion of site development within the overall drainage basin to the receiving Lacombe Lake is small providing Discharge Rate Control is considered adequate at this time.

3.3 DESIGN STORM

A Chicago design storm with a one in one-hundred (1:100) year return period, storm duration of 24 hours, and with a 5 minute time increment was used to analyze the pond volume storage requirements.

Rainfall intensities for the Chicago distribution were determined from an *intensity-duration-frequency* (IDF) relationship that is described as

$$i = a / (t + b)^c \qquad [1]$$

where i is intensity (mm/hr), a, b and c are IDF parameters and t is the time duration (minutes). The time to storm peak is determined by

$$t_p / t_d = r \qquad \text{or} \qquad t_p = r(t_d) \qquad [2]$$

where t_p is the time to peak and r is the ratio of time to peak versus storm duration, t_d.

The following parameters were used to derive the rainfall intensities for the design storm as provided in the City of Red Deer Stormwater Management Drainage Systems Design Standards:

$$a = 200 \qquad b = 26 \qquad c = 0.52 \qquad r = 0.3 \text{ (24 hour duration)}$$

The Intensity-Duration curve data used to generate the Chicago storm, and also the rainfall distribution as a function of time (storm hyetograph) for the Chicago storm can be found in Appendix A.

3.4 DESIGN OBJECTIVES

The objective of this study is to demonstrate that the proposed stormwater management facility can meet Alberta Environment (AENV) criteria for permissible release rate and water quality improvement.

The report will discuss Discharge Rate Control and stormwater quality improvement. For Discharge Rate Control a storm pond permissible release rate will be determined, and the effect of the proposed storm pond will also be commented on from a water quality improvement perspective.

SWMHYMO single event modeling found in Appendix A, will demonstrate the proposed stormwater management facility has adequate active storage to attenuate the peak flows resulting from a 24 hour duration, 1:100 year design storm event. SWMHYMO single event modeling will also shown the required capacity for the storm management facility for a zero release rate should the outlet become plugged and the pond is not allowed to drain freely.

The attached spreadsheet in Appendix B will demonstrate based on the equations found in both the “Stormwater Management Guidelines for the Province of Alberta” and “The City of Calgary - Wastewater and Drainage - Stormwater Management and Design Manual” that the proposed sediment forebay will provide the required water quality improvements.

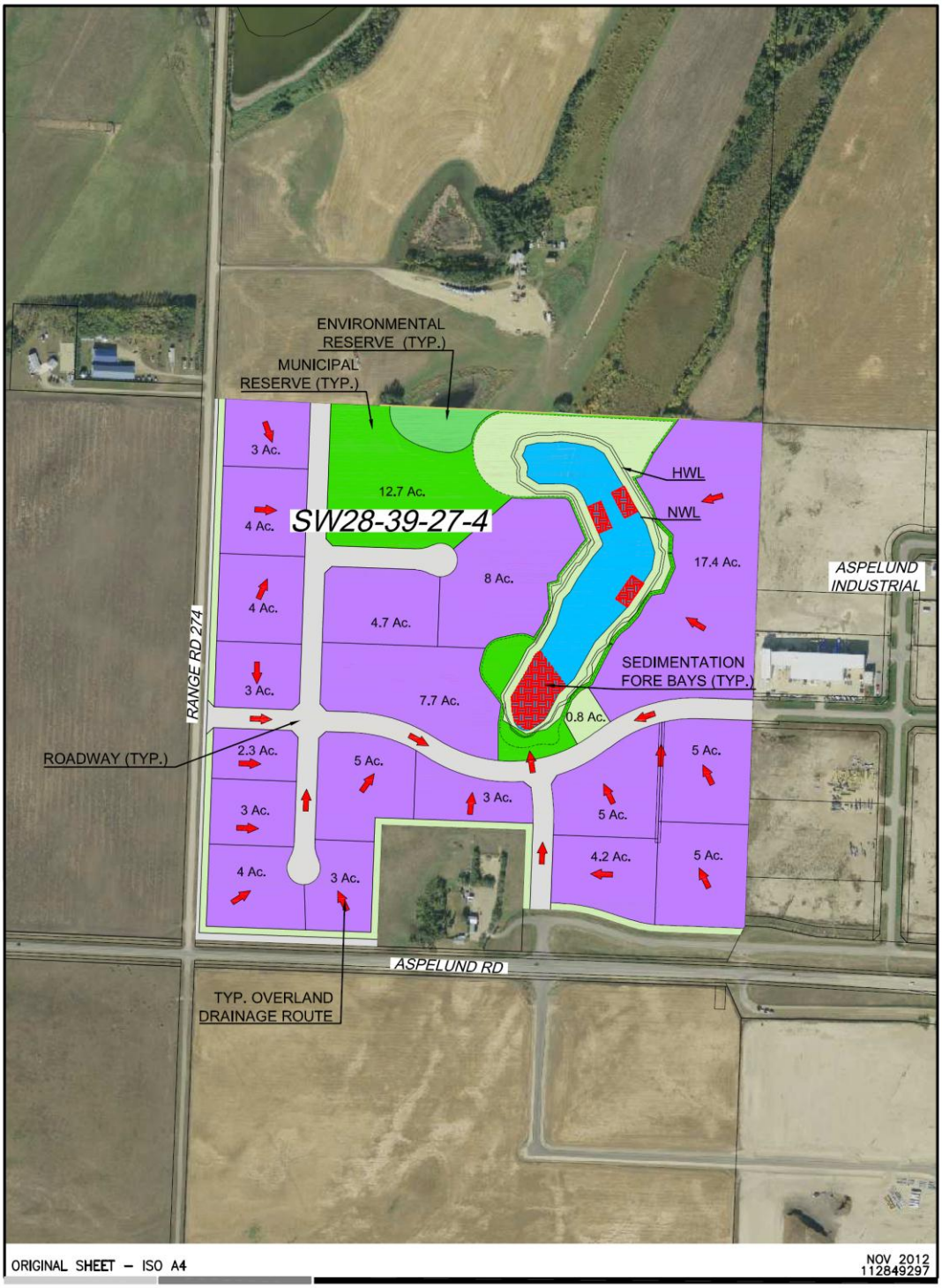

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Figure No.
3.0

Title
STORM WATER MANAGEMENT PLAN

4.0 Proposed Stormwater Management

4.1 DEVELOPMENT CONFIGURATION

The proposed development shall be graded such that the majority of the industrial development can have both the minor (roadside ditches) and major (overland flow) storm systems drain\spill to the proposed stormwater management facility located in the north central portion of the site. The entire site excluding fringe grading to tie to existing ground shall be directed to the stormwater management facility. Please refer to Figure 3.0 Stormwater Management Plan on the following page.

During roadway design Stantec shall employ vegetated ditches across the site such that stormwater runoff is pretreated in the ditches, prior to draining to the proposed hybrid storm pond/wetland ultimately. The flows from the development are intercepted and treated by the proposed storm water management facility, prior to discharging to the downstream portion of wetland 3, and ultimately to Lacombe Lake. The storm water management facility will be designed to meet Alberta Environment's criteria of providing a minimum of 85% removal of sediments 75µm and larger prior to discharge to the natural drainage course.

The Total Energy Services' development will have a dual drainage storm system. The Total Energy Services' development minor system (ditches and culverts) will be designed for the 1:5 year return period storm event using the Rational Method and the City of Red Deer IDF rainfall curves. Lacombe County does not have recorded rainfall data.

All runoff in excess of the minor system capacity will flow overland via roadways, which is typically referred to as the major system. It is important that developments have a properly designed overland drainage (major) system because poorly designed developments will still experience overland drainage, but often with consequences. In Alberta, major systems are typically designed such that property will not experience flood damage for storms up to and including the 1:100 year return period, and this is the standard that the Total Energy Services' development will be designed to.

Overland drainage shall conform to the Lacombe County Design Guidelines, and also the water velocity and depth relations as outlined in the Alberta Environment (AENV) Stormwater Management Guidelines.

4.2 STORMWATER MANAGEMENT FACILITY CONFIGURATION

A hybrid wet pond/wetland is proposed to provide the required stormwater quality control and detention time for the Total Energy Services' development. Wetlands 2 & 3 will be combined and a berm constructed on the northern property line of the site within wetland 3 to isolate it from the downstream wetland. The combined wetland will also be expanded to provide the necessary sediment control forebay and additional storage as required. An environmental reserve buffer will be placed around the proposed hybrid pond/wetland. All efforts will be made during construction to mitigate any potential damage to Wetlands 2 and 3 during the berm construction and the combining of the two wetlands.

The facility will have an outlet located in the northern berm of the hybrid wet pond/wetland. The facility will have an active depth of 1.1m. The facility will be graded and stormwater will be routed such that the site minor system inlet into the hybrid wet pond/wetlands will have an adequately sized sediment forebay to meet the required total suspended sediment removal requirements. All overland drainage from the proposed lots flanking the environmental reserve area will be graded to direct all flows to the four proposed sediment control bays to protect the the stormwater management facility.

Draw down time will be controlled by way of an outlet structure located within the northern berm of the pond. It will be a concrete manhole structure with a 292mm orifice set at the NWL, located in the inner chamber wall. The structure wall will also have a weir overflow at the HWL elevation. The structure will be buried deep enough to allow sufficient fill concrete to be installed in the base to counteract any buoyancy forces in a flooding event should the weight of the structure not suffice. The structure will outlet via a 675mm concrete pipe set to drain to a proposed level spreader prior to exiting the site.

The proposed stormwater management facility will attenuate flows down to pre-development levels and a vegetated riparian buffer between the outlet and the portion of wetland 3 off-site will be established. The out flow will exit the site as sheet flow from the level spreader prior to entering the proposed riparian buffer, therefore erosion of the downstream wetlands is not expected to be an issue.

Based on calculations previously demonstrated we are proposing to use a release rate of 3.1 L/s/ha.

5.0 Analysis and Results

5.1 STORM POND CATCHMENT AREA

Please see the previously provided Figure 3.0 to see the catchment that is proposed to be serviced by the Total Energy Services' stormwater management facilities. Table 5.2 below shows the catchment characteristics used in the single event SWMHYMO computer modeling, which was used to estimate the required pond storage volume requirements for the 24 hour, 1:100 year design storm. The SWMHYMO modeling data files can be found in Appendix A.

The proposed development is to be an industrial development so a weighted impervious value of 0.70 was used. This value is taken from Table 3.9: Typical Imperviousness of Urban Catchments from The City of Calgary - Wastewater and Drainage - Stormwater Management and Design Manual. The weighted value was calculated based on the parameters found in Table 5.1

Table 5.1 Impervious Area Characteristics

Sub-catchments	Area (ha)	Impervious Ratio	Description
1 - Industrial	42.8	0.85	Industrial
2 - Roadway	5.8	0.70	Roadway
3 – Storm Facility	2.7	1.00	Storm Facility

The modelling parameters used for runoff generation were based on anticipated surface coverage associated with the proposed land use. Roadways, sidewalks, and rooftops were considered impervious, while landscaped and naturalized areas were considered pervious. The SCN Curve Number Method (CN) was used with the computer program to generate a hydrograph for the lumped catchment area. A CN*II value of 72 was selected for all pervious areas (developed), and initial abstraction values of 3.2 mm and 1.6 mm were used for pervious and impervious areas, respectively.

Table 5.2 Pond Catchment Characteristics

Sub-catchments	Area (ha)	Impervious Ratio	LGI	CN*II Value	Description
1 - Site	64	0.70	575	72	Industrial

5.2 STORMWATER MANAGEMENT FACILITY

As previously mentioned, a hybrid wet pond/wetland is proposed for the Total Energy Services' development, and this facility will have an active depth of 1.10 m, and a permissible release rate of 3.1 L/s/ha. The Normal Water Level (NWL) and High Water Level (HWL) have been set at 878.30m and 879.40m, respectively. Please see Table 5.3 below, for the proposed stormwater facility characteristics. The discharge rate will be controlled with an orifice in a vaulted control structure. An orifice with a diameter of 292mm is proposed, with the invert set to the facility Normal Water Level (NWL) elevation.

Table 5.3 Stormwater Facility Characteristics

Description	Elevation (m)	Active Depth (m)	Surface Area (m^2)	Total Volume (m^3)	Active Volume (m^3)	Outfall Discharge (L/s)
	878.00	-0.30	30600	0	0	0.0
NWL	878.30	0.00	35215	9864	0	69.8
	878.70	0.40	39697	24838	14973	132.3
	878.75	0.45	40257	26836	16972	138.1
	878.90	0.60	41938	33001	23136	154.3
	879.05	0.75	43618	39417	29553	169.0
	879.20	0.90	45299	46085	36221	182.5
	879.35	1.05	46980	53006	43142	195.0
HWL	879.40	1.10	47540	55369	45505	199.0
Orifice Diameter (mm)		292				
Orifice Elevation (m)		878.00				
Orifice Number		1				
SWMHYMO 1:100 (m^3)					45,410	

The SWMHYMO Single Event modeling estimates that an active pond storage volume of 45,410 m^3 is required to attenuate the peak flows resulting from a 24 hour duration, 1:100 year design storm event. As can been seen in Table 5.3 above the proposed stormwater facility provides the necessary active storage volume assuming backwater conditions do not occur at the outlet. Please also note that the proposed release rate of 199.2 L/s is at/below the permissible release rate calculated as 64.25 ha x 3.1 L/s/ha = 199.2 L/s.

The SWMHYMO Single Event modeling estimates that an active pond storage volume of 58,690 m^3 is required should the outlet become clogged. This volume will be provided prior to the emergency overflow elevation. This elevation will be determined in detailed design.

5.3 WATER QUALITY IMPROVEMENT

As previously mentioned, the proposed facility is to have adequately sized sediment forebays where the major(overland) and minor drainage systems (roadside ditches) enter the facility. Sediment forebay berms will be graded within the hybrid wet pond/wetland to provide a forebay for each inlet. These forebays will be sized at a minimum as modeled in the spreadsheet in Appendix B. The spreadsheet contains output that demonstrates the proposed forebays are adequately sized to meet the dimensioning criteria provided in Alberta Environment's Stormwater Management Guidelines. The dimensioning criteria are based on formulas that utilize settling velocity and dispersion velocity concepts. The sediment forebay inflow and outflow parameters were taken as that which will ultimately be experienced under full build out conditions.

Given the proposed stormwater management facility will have four adequately sized sediment forebays at each inlet location, we are confident that the proposed stormwater management facility will meet Alberta Environment's requirement for removing 85% of Total Suspended Solids (TSS) for particles greater than or equal to 75 microns in diameter.

5.4 CURRENT LACOMBE LAKE WATER QUALITY ISSUES

General concerns of the water quality of the ultimate receiving facility Lacombe Lake have been raised by the surrounding land owners and recreational users of Lacombe Lake. The Lacombe Lake Water Quality Report 2008, prepared by Aquality Environmental Consulting Ltd., dated June 12, 2008 has been reviewed and based on general findings and the conclusions drawn in the report, the derogation of Lacombe Lake's water quality is due to an inflow creek to the north of the Lake.

The report states that the inflow creek concentrations of total and fecal coliform bacteria are well above Canadian Council of Ministers of Environment (CCME) Irrigation guidelines, in addition to elevated levels of total phosphorus; total Kjeldahl nitrogen and total dissolved solid concentrations.

Given the main concern for the water quality derogation is an inflow creek to the north of the lake we are confident that water quality of Lacombe Lake will not be adversely affected by the proposed development. In the remote chance any of the aforementioned pollutions from the proposed development enter the stormwater management facility, due to the nature of a wetland ecosystem, most if not all of the potential pollutions would be dealt with prior to entering the lake ecosystem.

5.5 DETENTION TIME

As per Alberta Environment's Stormwater Management Guidelines, stormwater management facilities must provide a minimum 24 hour (1 day) detention time to promote stormwater quality enhancement. This is generally defined as the theoretical time required to displace the contents of a stormwater pond at a given rate of discharge (i.e. active storage volume required divided by rate of discharge). The detention time of the ultimate facility is calculated as follows:

Active storage volume required = 45, 410 m^3

Peak outflow = 0.199 m^3/s

Detention time = 45,410 m^3 / 0.199 m^3/s = 226,834 sec or 74.1 hours > 24 hours.

6.0 Conclusions and Recommendations

As part of the proposed industrial development of the Total Energy Services' Subdivision located in Lacombe County, a hybrid wet pond/wetland is proposed to provide the required storm water quality improvements and detention time as set by Alberta Environment.

The proposed pond has been modeled using SWYHYMO. The model has demonstrated that the proposed stormwater management facilities can meet Alberta Environment (AENV) criteria for permissible release rate and water quality improvement. The model has demonstrated to provide adequate storage given the recommended control structure to attenuate the peak flows resulting from a 24 hour duration, 1:100 year design storm event. Sediment forebays will be provided to reduce the effluent TSS count and the hybrid wet pond/wetland provides enough active storage to provide a detention time exceeding 24 hours.

7.0 References

Stormwater Management Guidelines for the Province of Alberta, Alberta Environmental Protection, January 1999.

Municipal Policies and Procedures Manual, Alberta Environmental Protection, April 2001.

SWMHYMO - Stormwater Management Hydrologic Model, User's Manual, J.F. Sabourin and Associates Inc., 1998.

The Town of Blackfalds – Engineering Services Design Guidelines, 2011.

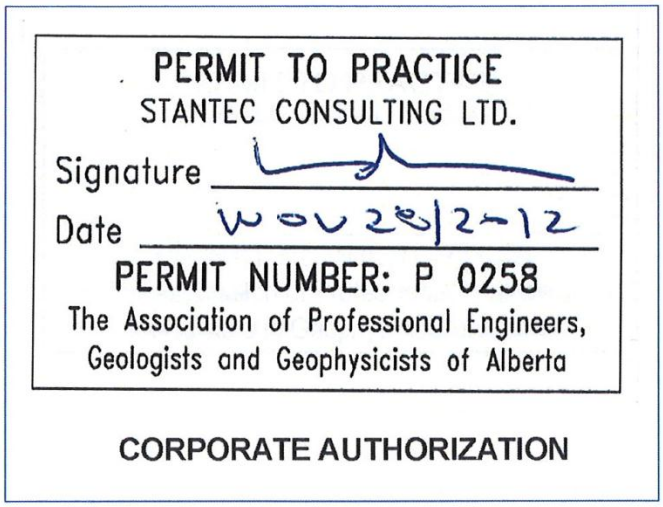
The City of Calgary - Wastewater and Drainage - Stormwater Management and Design Manual, December 2000.

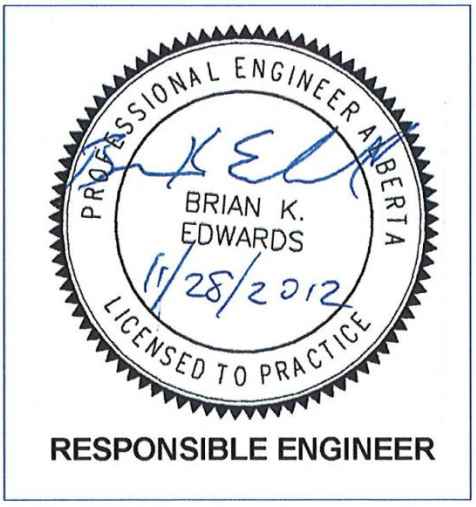
Lacombe Lake Water Quality Report 2008, Aquality Environmental Consulting Ltd., June 12 2008

TES Industrial Development Wetland Assessment, Stantec Consulting Ltd., November 2011

8.0 Corporate Authorization

This document entitled "**Total Energy Services, Inc. Industrial Park SW28-39-27-W.4 Stormwater Management Plan**" was prepared by Stantec Consulting Ltd. on behalf of Total Energy Services Inc. The material in it reflects Stantec Consulting Ltd.'s best judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or reliance on or decisions made based on it, are the responsibilities of such third parties. Stantec Consulting Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.





Submitted by
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November 28, 2012

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Appendix A – SWMHYMO Input & Output Files

```
2     Metric units
*#*************************************************************************
*#  Project Name: [TES Industrial - Lacombe County]    Project Number: [112849297]
*#  Date Created: November 27, 2012
*#  File Name   : tes1.DAT
*#  Modeller    : [BKE]
*#  Reviewed By : []
*#  Company     : Stantec Consulting
*#  License #   : 3493728
*#
*#  Client      : U/K
*#  Description : Stormwater Modeling for Site Constructed Wetland
*#              :
*#              : 1 Hour, 1:100 year storm event with "Chicago" Distribution
*#
*#  Revised     :3.1 L/s/Ha Release based on Future Wolf Creek Basin Drainage Plan
*#
*#
*#*************************************************************************
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[0],  NRUN=[0]
*%                   [  ] <--storm filename, one per line for NSTORM time
*%-----------------|-------------------------------------------------------|
**************************************************************************
**************************************************************************
*
*  INPUT 100 YEAR CHICAGO STORM (A, B, C, parameters as per City of
*  Red Deer guidelines for 100 year storm)
*
*
**************************************************************************
**************************************************************************
CHICAGO STORM       IUNITS=[2],  TD=[24](hrs), TPRAT=[0.3],  CSDT=[5](min),
                    ICASEcs=[1],
                    A=[200],  B=[26], and C=[0.52],
*%-----------------|-------------------------------------------------------|
**************************************************************************
*
*  Existing Site                                            Area=32.6 ha
*
**************************************************************************
CALIB NASHYD        ID=[1], NHYD=["EXSITE"], DT=[5]min, AREA=[32.6](ha),
                    DWF=[0.0](cms),  CN/C=[74], IA=[3.2](mm),
                    N=[2], TP=[12.4]hrs,
                    RAINFALL=[ ,  ,  ,  , ](mm/hr),  END=-1
*%-----------------|-------------------------------------------------------|
**************************************************************************
*
*  Site                                             Area=64.5 ha
*
**************************************************************************
CALIB STANDHYD      ID=[2], NHYD=["1"], DT=[1.0](min), AREA=[64.5](ha),
                    XIMP=[0.70], TIMP=[0.70], DWF=[0.0](cms), LOSS=[2],
                    SCS curve number CN=[72],
                    Pervious   surfaces: IAper=[3.2](mm), SLPP=[2.0](%),
                                         LGP=[40](m), MNP=[0.25], SCP=[0](min),
                    Impervious surfaces: IAimp=[1.6](mm), SLPI=[1.0](%),
                                         LGI=[575](m), MNI=[0.013], SCI=[0](min),
```

```
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-------------------------------------------------------------|
*******************************************************************************
* ROUTE RESERVOIR - Storm Pond
* NWL=878.3
* HWL (Design) =879.4
* MAXIMUM HWL ELEVATION ESTIMATED AT
*
* SUB-CATCHMENTS:
* RELEASE RATE = 64.5 ha * 3.1 L/s/ha = 199.2 L/s
*
ROUTE RESERVOIR     IDout=[3],   NHYD=[102],  IDin=[2],
                    RDT=[1.0](min),

                          TABLE of ( OUTFLOW-STORAGE ) values
                                     (cms) - (ha-m)
                                   [0.0698,0.0000]
                                   [0.1323,1.4973]
                                   [0.1381,1.6972]
                                   [0.1543,2.3136]
                                   [0.1690,2.9553]
                                   [0.1825,3.6221]
                                   [0.1950,4.3142]
                                   [0.1990,4.5505]
                                   [0.2286,6.5465]
                                   [  -1 , -1  ]  (max twenty pts)
                                IDovf=[  ], NHYDovf=[  ]
*%-----------------|-------------------------------------------------------------|
*******************************************************************************
*  Pond Characteristics
*******************************************************************************
*    Description    Elevation    Depth      Area     Volume    Discharge
*                   (m)           (m)        (m2)         (m3)         (m3/s)
*                   878.00        -0.30        30600       0          0.0000
*      NWL          878.30        0.00        35215       0       0.0698
*                   878.70        0.40        39697       14973          0.1323
*                   878.75        0.45        40257       16972          0.1381
*                   878.90        0.60        41938       23136          0.1543
*                   879.05        0.75        43618       29553          0.1690
*                   879.20        0.90        45299       36221          0.1825
*                   879.35        1.05        46980       43142          0.1950
*      HWL          879.40        1.10        47540       45505       0.1990
*      FB           879.80        1.50        52300        65465       0.2286
*******************************************************************************
*
*
FINISH
```

```
================================================================================

   SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO        999    999    =========
   S      W W W  MM MM  H   H   Y Y   MM MM  O   O      9   9  9   9
   SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O  ##  9   9  9   9   Ver  4.05
       S   W W   M   M  H   H    Y    M   M  O   O       9999   9999   Sept 2011
   SSSSS   W W   M   M  H   H    Y    M   M   OOO           9      9    =========
                                                        9   9  9   9   # 3493728
         StormWater Management HYdrologic Model          999    999    =========

 ********************************************************************************
 ***************************** SWMHYMO Ver/4.05  ********************************
 *********  A single event and continuous hydrologic simulation model  *********
 *********     based on the principles of HYMO and its successors      *********
 *********                  OTTHYMO-83 and OTTHYMO-89.                  *********
 ********************************************************************************
 ********* Distributed by:  J.F. Sabourin and Associates Inc.          *********
 *********                   Ottawa,  Ontario: (613) 836-3884          *********
 *********                   Gatineau, Quebec: (819) 243-6858          *********
 *********                   E-Mail: swmhymo@jfsa.Com                  *********
 ********************************************************************************

 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 +++++++++ Licensed user: Stantec Consulting LTD                       +++++++++
 +++++++++                Red Deer              SERIAL#:3493728        +++++++++
 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

 ********************************************************************************
 *********           ++++++ PROGRAM ARRAY DIMENSIONS ++++++             *********
 *********           Maximum value for ID numbers  :     10            *********
 *********           Max. number of rainfall points: 105408            *********
 *********           Max. number of flow points    : 105408            *********
 ********************************************************************************


 **********************   D E T A I L E D   O U T P U T   **********************
 ********************************************************************************
 *         DATE: 2012-11-27     TIME: 10:35:21     RUN COUNTER: 000143          *
 ********************************************************************************
 * Input   filename: C:\PROGRA~2\SWMHYMO\PROJECTS\TES\tes1.dat                   *
 * Output  filename: C:\PROGRA~2\SWMHYMO\PROJECTS\TES\tes1.out                   *
 * Summary filename: C:\PROGRA~2\SWMHYMO\PROJECTS\TES\tes1.sum                   *
 * User comments:                                                               *
 * 1:_____________________________________________________________________________*
 * 2:_____________________________________________________________________________*
 * 3:_____________________________________________________________________________*
 ********************************************************************************

--------------------------------------------------------------------------------
001:0001----------------------------------------------------------------------
*#*****************************************************************************
*#  Project Name: [TES Industrial - Lacombe County]    Project Number: [11284929
*#  Date Created: November 27, 2012
*#  File Name   : tes1.DAT
*#  Modeller    : [BKE]
*#  Reviewed By : []
*#  Company     : Stantec Consulting
*#  License #   : 3493728
```

```
*#
*#  Client      : U/K
*#  Description : Stormwater Modeling for Site Constructed Wetland
*#              :
*#              : 1 Hour, 1:100 year storm event with "Chicago" Distribution
*#
*#  Revised     :3.1 L/s/Ha Release based on Future Wolf Creek Basin Drainage Pl
*#
*#
*#*************************************************************************
--------------------
| START            |  Project  dir.: C:\PROGRA~2\SWMHYMO\PROJECTS\TES\
--------------------  Rainfall dir.: C:\PROGRA~2\SWMHYMO\PROJECTS\TES\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 001
    NSTORM=   0
-------------------------------------------------------------------------------
001:0002----------------------------------------------------------------------
*************************************************************************
*************************************************************************
*
*  INPUT 100 YEAR CHICAGO STORM (A, B, C, parameters as per City of
*  Red Deer guidelines for 100 year storm)
*
*
*************************************************************************
*************************************************************************
--------------------
| CHICAGO STORM    |    IDF curve parameters: A= 200.000
| Ptotal=108.35 mm |                          B=  26.000
--------------------                          C=    .520
                         used in:   INTENSITY =  A / (t + B)^C

                         Duration of storm  = 24.00 hrs
                         Storm time step    =  5.00 min
                         Time to peak ratio =   .30
```

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.08	2.231	6.08	6.217	12.08	4.262	18.08	2.775
.17	2.245	6.17	6.506	12.17	4.223	18.17	2.764
.25	2.259	6.25	6.837	12.25	4.185	18.25	2.753
.33	2.274	6.33	7.220	12.33	4.149	18.33	2.742
.42	2.289	6.42	7.669	12.42	4.113	18.42	2.731
.50	2.304	6.50	8.207	12.50	4.078	18.50	2.720
.58	2.319	6.58	8.865	12.58	4.044	18.58	2.710
.67	2.335	6.67	9.691	12.67	4.010	18.67	2.699
.75	2.351	6.75	10.767	12.75	3.978	18.75	2.689
.83	2.367	6.83	12.239	12.83	3.946	18.83	2.679
.92	2.384	6.92	14.395	12.92	3.915	18.92	2.668
1.00	2.401	7.00	17.910	13.00	3.885	19.00	2.658
1.08	2.419	7.08	24.797	13.08	3.855	19.08	2.649
1.17	2.437	7.17	33.537	13.17	3.826	19.17	2.639
1.25	2.455	7.25	27.709	13.25	3.797	19.25	2.629
1.33	2.473	7.33	23.167	13.33	3.770	19.33	2.619
1.42	2.492	7.42	20.066	13.42	3.742	19.42	2.610
1.50	2.512	7.50	17.811	13.50	3.716	19.50	2.601
1.58	2.532	7.58	16.095	13.58	3.690	19.58	2.591
1.67	2.552	7.67	14.742	13.67	3.664	19.67	2.582

1.75	2.573	7.75	13.647	13.75	3.639	19.75	2.573
1.83	2.594	7.83	12.740	13.83	3.614	19.83	2.564
1.92	2.616	7.92	11.975	13.92	3.590	19.92	2.555
2.00	2.639	8.00	11.321	14.00	3.567	20.00	2.546
2.08	2.662	8.08	10.754	14.08	3.543	20.08	2.537
2.17	2.685	8.17	10.257	14.17	3.521	20.17	2.529
2.25	2.710	8.25	9.818	14.25	3.498	20.25	2.520
2.33	2.735	8.33	9.426	14.33	3.476	20.33	2.512
2.42	2.760	8.42	9.074	14.42	3.455	20.42	2.503
2.50	2.786	8.50	8.756	14.50	3.434	20.50	2.495
2.58	2.813	8.58	8.467	14.58	3.413	20.58	2.487
2.67	2.841	8.67	8.203	14.67	3.392	20.67	2.479
2.75	2.870	8.75	7.961	14.75	3.372	20.75	2.471
2.83	2.899	8.83	7.737	14.83	3.352	20.83	2.463
2.92	2.930	8.92	7.530	14.92	3.333	20.92	2.455
3.00	2.961	9.00	7.338	15.00	3.314	21.00	2.447
3.08	2.993	9.08	7.159	15.08	3.295	21.08	2.439
3.17	3.027	9.17	6.992	15.17	3.277	21.17	2.431
3.25	3.061	9.25	6.835	15.25	3.259	21.25	2.424
3.33	3.097	9.33	6.688	15.33	3.241	21.33	2.416
3.42	3.134	9.42	6.549	15.42	3.223	21.42	2.409
3.50	3.172	9.50	6.419	15.50	3.206	21.50	2.401
3.58	3.212	9.58	6.295	15.58	3.189	21.58	2.394
3.67	3.253	9.67	6.178	15.67	3.172	21.67	2.387
3.75	3.295	9.75	6.067	15.75	3.155	21.75	2.379
3.83	3.340	9.83	5.961	15.83	3.139	21.83	2.372
3.92	3.386	9.92	5.861	15.92	3.123	21.92	2.365
4.00	3.434	10.00	5.765	16.00	3.107	22.00	2.358
4.08	3.484	10.08	5.673	16.08	3.092	22.08	2.351
4.17	3.536	10.17	5.586	16.17	3.076	22.17	2.344
4.25	3.590	10.25	5.502	16.25	3.061	22.25	2.337
4.33	3.647	10.33	5.422	16.33	3.046	22.33	2.330
4.42	3.707	10.42	5.345	16.42	3.032	22.42	2.324
4.50	3.770	10.50	5.271	16.50	3.017	22.50	2.317
4.58	3.836	10.58	5.200	16.58	3.003	22.58	2.310
4.67	3.905	10.67	5.132	16.67	2.989	22.67	2.304
4.75	3.978	10.75	5.066	16.75	2.975	22.75	2.297
4.83	4.055	10.83	5.002	16.83	2.961	22.83	2.291
4.92	4.137	10.92	4.941	16.92	2.947	22.92	2.284
5.00	4.223	11.00	4.882	17.00	2.934	23.00	2.278
5.08	4.316	11.08	4.825	17.08	2.921	23.08	2.272
5.17	4.414	11.17	4.770	17.17	2.908	23.17	2.265
5.25	4.519	11.25	4.716	17.25	2.895	23.25	2.259
5.33	4.631	11.33	4.664	17.33	2.882	23.33	2.253
5.42	4.752	11.42	4.614	17.42	2.870	23.42	2.247
5.50	4.882	11.50	4.565	17.50	2.857	23.50	2.241
5.58	5.024	11.58	4.518	17.58	2.845	23.58	2.235
5.67	5.177	11.67	4.472	17.67	2.833	23.67	2.229
5.75	5.346	11.75	4.428	17.75	2.821	23.75	2.223
5.83	5.530	11.83	4.385	17.83	2.810	23.83	2.217
5.92	5.735	11.92	4.343	17.92	2.798	23.92	2.211
6.00	5.962	12.00	4.302	18.00	2.786	24.00	2.205

```
--------------------------------------------------------------------------------
001:0003----------------------------------------------------------------------
********************************************************************************
*
*  Existing Site                                          Area=32.6 ha
*
********************************************************************************
```

```
----------------------
| CALIB NASHYD       |   Area    (ha)=   32.60   Curve Number   (CN)=74.00
| 01:EXSITE DT= 5.00 |   Ia      (mm)=   3.200   # of Linear Res.(N)= 2.00
----------------------   U.H. Tp(hrs)=  12.400

     Unit Hyd Qpeak  (cms)=     .068

     PEAK FLOW       (cms)=     .141 (i)
     TIME TO PEAK    (hrs)=   27.333
     RUNOFF VOLUME    (mm)=   56.881
     TOTAL RAINFALL   (mm)=  108.355
     RUNOFF COEFFICIENT   =     .525

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
001:0004----------------------------------------------------------------------
********************************************************************************
*
*  Site                                                 Area=64.5 ha
*
********************************************************************************
----------------------
| CALIB STANDHYD     |   Area    (ha)=   64.50
| 02:1      DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   70.00
----------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=      45.15        19.35
     Dep. Storage     (mm)=       1.60         3.20
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     575.00        40.00
     Mannings n           =       .013         .250

     Max.eff.Inten.(mm/hr)=      29.65        10.64
               over (min)        12.00        29.00
     Storage Coeff.  (min)=      11.87 (ii)   29.16 (ii)
     Unit Hyd. Tpeak (min)=      12.00        29.00
     Unit Hyd. peak  (cms)=        .10          .04
                                                      *TOTALS*
     PEAK FLOW       (cms)=       3.03          .42         3.314 (iii)
     TIME TO PEAK    (hrs)=       7.38         7.83         7.400
     RUNOFF VOLUME    (mm)=     106.73        54.19        90.995
     TOTAL RAINFALL   (mm)=     108.35       108.35       108.355
     RUNOFF COEFFICIENT   =        .98          .50          .840

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  72.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
001:0005----------------------------------------------------------------------
********************************************************************************
* ROUTE RESERVOIR - Storm Pond
* NWL=878.3
* HWL (Design) =879.4
* MAXIMUM HWL ELEVATION ESTIMATED AT
*
* SUB-CATCHMENTS:
```

```
* RELEASE RATE = 64.5 ha * 3.1 L/s/ha = 199.2 L/s
*
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>02:(1     )   |
| OUT<03:(000102)   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
      *** WARNING: First OUTFLOW value in table should be ZERO.
                          .070  .0000E+00   |     .183  .3622E+01
                          .132  .1497E+01   |     .195  .4314E+01
                          .138  .1697E+01   |     .199  .4550E+01
                          .154  .2314E+01   |     .229  .6547E+01
                          .169  .2955E+01   |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >02: (1     )      64.50     3.314     7.400     90.995
     OUTFLOW<03: (000102)      64.50      .199    24.283     90.998

                  PEAK   FLOW   REDUCTION [Qout/Qin](%)=    5.999
                  TIME SHIFT OF PEAK FLOW         (min)=  1013.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=.4541E+01

--------------------------------------------------------------------------------
001:0006----------------------------------------------------------------------
********************************************************************************
*  Pond Characteristics
********************************************************************************
*    Description    Elevation    Depth      Area     Volume    Discharge
*                   (m)          (m)        (m2)         (m3)         (m3/s)
*                   878.00       -0.30        30600       0          0.0000
*      NWL          878.30       0.00         35215       0       0.0698
*                   878.70       0.40         39697       14973          0.1323
*                   878.75       0.45         40257       16972          0.1381
*                   878.90       0.60         41938       23136          0.1543
*                   879.05       0.75         43618       29553          0.1690
*                   879.20       0.90         45299       36221          0.1825
*                   879.35       1.05         46980       43142          0.1950
*      HWL          879.40       1.10         47540       45505       0.1990
*      FB           879.80       1.50         52300        65465       0.2286
********************************************************************************
*
*
      FINISH
--------------------------------------------------------------------------------
********************************************************************************
     WARNINGS / ERRORS / NOTES
     -------------------------
 001:0005 ROUTE RESERVOIR
      *** WARNING: First OUTFLOW value in table should be ZERO.
   Simulation ended on 2012-11-27     at 10:35:21
================================================================================
```

```
2     Metric units
*#************************************************************************
*#  Project Name: [TES Industrial - Lacombe County]    Project Number: [112849297]
*#  Date Created: Nov 27, 2012
*#  File Name   : tes0.DAT
*#  Modeller    : [BKE]
*#  Reviewed By : []
*#  Company     : Stantec Consulting
*#  License #   : 3493728
*#
*#  Client      : U/K
*#  Description : Stormwater Modeling for Phase 1 Wetland - Zero Release
*#              :
*#              : 1 Hour, 1:100 year storm event with "Chicago" Distribution
*#
*#  Revised     :3.1 L/s/Ha Release based on Future Wolf Creek Basin Drainage Plan
*#
*#
*#************************************************************************
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[0],  NRUN=[0]
*%                   [  ] <--storm filename, one per line for NSTORM time
*%-----------------|-------------------------------------------------------|
**************************************************************************
**************************************************************************
*
*  INPUT 100 YEAR CHICAGO STORM (A, B, C, parameters as per City of
*  Red Deer guidelines for 100 year storm)
*
*
**************************************************************************
**************************************************************************
CHICAGO STORM       IUNITS=[2],  TD=[24](hrs), TPRAT=[0.3],  CSDT=[5](min),
                    ICASEcs=[1],
                    A=[200],  B=[26], and C=[0.52],
*%-----------------|-------------------------------------------------------|
**************************************************************************
*
*  Existing Site                                              Area=32.6 ha
*
**************************************************************************
CALIB NASHYD        ID=[1], NHYD=["EXSITE"], DT=[5]min, AREA=[32.6](ha),
                    DWF=[0.0](cms),  CN/C=[74], IA=[3.2](mm),
                    N=[2], TP=[12.4]hrs,
                    RAINFALL=[ ,  ,  ,  , ](mm/hr),  END=-1
*%-----------------|-------------------------------------------------------|
**************************************************************************
*
*  Site                                          Area=64.5 ha
*
**************************************************************************
CALIB STANDHYD      ID=[2], NHYD=["1"], DT=[1.0](min), AREA=[64.5](ha),
                    XIMP=[0.70], TIMP=[0.70], DWF=[0.0](cms), LOSS=[2],
                    SCS curve number CN=[72],
                    Pervious   surfaces: IAper=[3.2](mm), SLPP=[2.0](%),
                                         LGP=[40](m), MNP=[0.25], SCP=[0](min),
                    Impervious surfaces: IAimp=[1.6](mm), SLPI=[1.0](%),
                                         LGI=[575](m), MNI=[0.013], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-------------------------------------------------------|
```

```
*****************************************************************************
* ROUTE RESERVOIR - Storm Pond
* NWL=877.3
* HWL (Design) =878.4
* MAXIMUM HWL ELEVATION ESTIMATED AT
*
* SUB-CATCHMENTS:
* RELEASE RATE = 64.5 ha * 3.1 L/s/ha = 199.2 L/s
*
ROUTE RESERVOIR     IDout=[3],   NHYD=[102],  IDin=[2],
                    RDT=[1.0](min),

                          TABLE of ( OUTFLOW-STORAGE ) values
                                     (cms) - (ha-m)
                                   [0.0000,0.0000]
                                   [0.0000,1.4973]
                                   [0.0000,1.6972]
                                   [0.0000,2.3136]
                                   [0.0000,2.9553]
                                   [0.0000,3.6221]
                                   [0.0000,4.3142]
                                   [0.0000,4.5505]
                                   [0.0000,6.5465]
                                   [  -1 , -1  ]  (max twenty pts)
                               IDovf=[  ], NHYDovf=[  ]
*%-----------------|-----------------------------------------------------------|
*****************************************************************************
*  Pond Characteristics
*****************************************************************************
*    Description    Elevation    Depth      Area     Volume    Discharge
*                   (m)           (m)        (m2)         (m3)         (m3/s)
*                   878.00        -0.30        30600       0          0.0000
*      NWL          878.30        0.00        35215       0       0.0000
*                   878.70        0.40        39697       14973          0.0000
*                   878.75        0.45        40257       16972          0.0000
*                   878.90        0.60        41938       23136          0.0000
*                   879.05        0.75        43618       29553          0.0000
*                   879.20        0.90        45299       36221          0.0000
*                   879.35        1.05        46980       43142          0.0000
*      HWL          879.40        1.10        47540       45505       0.0000
*      FB           879.80        1.50        52300        65465       0.0000
*****************************************************************************
*
*
FINISH
```

```
================================================================================

   SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO        999    999    =========
   S      W W W  MM MM  H   H   Y Y   MM MM  O   O      9   9  9   9
   SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O  ##  9   9  9   9   Ver  4.05
       S   W W   M   M  H   H    Y    M   M  O   O       9999   9999   Sept 2011
   SSSSS   W W   M   M  H   H    Y    M   M   OOO           9      9   =========
                                                        9   9  9   9   # 3493728
        StormWater Management HYdrologic Model           999    999    =========

 ********************************************************************************
 ***************************** SWMHYMO Ver/4.05  ********************************
 *********  A single event and continuous hydrologic simulation model  *********
 *********     based on the principles of HYMO and its successors      *********
 *********                 OTTHYMO-83 and OTTHYMO-89.                  *********
 ********************************************************************************
 ********* Distributed by:  J.F. Sabourin and Associates Inc.          *********
 *********                   Ottawa,  Ontario: (613) 836-3884          *********
 *********                   Gatineau, Quebec: (819) 243-6858          *********
 *********                   E-Mail: swmhymo@jfsa.Com                  *********
 ********************************************************************************

 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 +++++++++ Licensed user: Stantec Consulting LTD                       +++++++++
 +++++++++                Red Deer              SERIAL#:3493728        +++++++++
 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

 ********************************************************************************
 *********           ++++++ PROGRAM ARRAY DIMENSIONS ++++++             *********
 *********           Maximum value for ID numbers  :     10            *********
 *********           Max. number of rainfall points: 105408            *********
 *********           Max. number of flow points    : 105408            *********
 ********************************************************************************


 **********************   D E T A I L E D   O U T P U T   **********************
 ********************************************************************************
 *         DATE: 2012-11-27     TIME: 10:38:53     RUN COUNTER: 000144          *
 ********************************************************************************
 * Input   filename: C:\PROGRA~2\SWMHYMO\PROJECTS\TES\tes0.dat                   *
 * Output  filename: C:\PROGRA~2\SWMHYMO\PROJECTS\TES\tes0.out                   *
 * Summary filename: C:\PROGRA~2\SWMHYMO\PROJECTS\TES\tes0.sum                   *
 * User comments:                                                               *
 * 1:_____________________________________________________________________________*
 * 2:_____________________________________________________________________________*
 * 3:_____________________________________________________________________________*
 ********************************************************************************

--------------------------------------------------------------------------------
001:0001----------------------------------------------------------------------------
*#*****************************************************************************
*#  Project Name: [TES Industrial - Lacombe County]    Project Number: [11284929
*#  Date Created: Nov 27, 2012
*#  File Name   : tes0.DAT
*#  Modeller    : [BKE]
*#  Reviewed By : []
*#  Company     : Stantec Consulting
*#  License #   : 3493728
*#
*#  Client      : U/K
```

```
*#  Description : Stormwater Modeling for Phase 1 Wetland - Zero Release
*#              :
*#              : 1 Hour, 1:100 year storm event with "Chicago" Distribution
*#
*#  Revised     :3.1 L/s/Ha Release based on Future Wolf Creek Basin Drainage Pl
*#
*#
*#*************************************************************************
--------------------
| START            |  Project  dir.: C:\PROGRA~2\SWMHYMO\PROJECTS\TES\
--------------------  Rainfall dir.: C:\PROGRA~2\SWMHYMO\PROJECTS\TES\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 001
    NSTORM=   0
-------------------------------------------------------------------------------
001:0002---------------------------------------------------------------------------
*******************************************************************************
*******************************************************************************
*
*  INPUT 100 YEAR CHICAGO STORM (A, B, C, parameters as per City of
*  Red Deer guidelines for 100 year storm)
*
*
*******************************************************************************
*******************************************************************************
--------------------
| CHICAGO STORM    |    IDF curve parameters: A= 200.000
| Ptotal=108.35 mm |                          B=  26.000
--------------------                          C=    .520
                         used in:   INTENSITY =  A / (t + B)^C

                         Duration of storm  = 24.00 hrs
                         Storm time step    =  5.00 min
                         Time to peak ratio =   .30

               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
                .08   2.231 |   6.08   6.217 |  12.08   4.262 |  18.08   2.775
                .17   2.245 |   6.17   6.506 |  12.17   4.223 |  18.17   2.764
                .25   2.259 |   6.25   6.837 |  12.25   4.185 |  18.25   2.753
                .33   2.274 |   6.33   7.220 |  12.33   4.149 |  18.33   2.742
                .42   2.289 |   6.42   7.669 |  12.42   4.113 |  18.42   2.731
                .50   2.304 |   6.50   8.207 |  12.50   4.078 |  18.50   2.720
                .58   2.319 |   6.58   8.865 |  12.58   4.044 |  18.58   2.710
                .67   2.335 |   6.67   9.691 |  12.67   4.010 |  18.67   2.699
                .75   2.351 |   6.75  10.767 |  12.75   3.978 |  18.75   2.689
                .83   2.367 |   6.83  12.239 |  12.83   3.946 |  18.83   2.679
                .92   2.384 |   6.92  14.395 |  12.92   3.915 |  18.92   2.668
               1.00   2.401 |   7.00  17.910 |  13.00   3.885 |  19.00   2.658
               1.08   2.419 |   7.08  24.797 |  13.08   3.855 |  19.08   2.649
               1.17   2.437 |   7.17  33.537 |  13.17   3.826 |  19.17   2.639
               1.25   2.455 |   7.25  27.709 |  13.25   3.797 |  19.25   2.629
               1.33   2.473 |   7.33  23.167 |  13.33   3.770 |  19.33   2.619
               1.42   2.492 |   7.42  20.066 |  13.42   3.742 |  19.42   2.610
               1.50   2.512 |   7.50  17.811 |  13.50   3.716 |  19.50   2.601
               1.58   2.532 |   7.58  16.095 |  13.58   3.690 |  19.58   2.591
               1.67   2.552 |   7.67  14.742 |  13.67   3.664 |  19.67   2.582
               1.75   2.573 |   7.75  13.647 |  13.75   3.639 |  19.75   2.573
               1.83   2.594 |   7.83  12.740 |  13.83   3.614 |  19.83   2.564
```

1.92	2.616	7.92	11.975	13.92	3.590	19.92	2.555
2.00	2.639	8.00	11.321	14.00	3.567	20.00	2.546
2.08	2.662	8.08	10.754	14.08	3.543	20.08	2.537
2.17	2.685	8.17	10.257	14.17	3.521	20.17	2.529
2.25	2.710	8.25	9.818	14.25	3.498	20.25	2.520
2.33	2.735	8.33	9.426	14.33	3.476	20.33	2.512
2.42	2.760	8.42	9.074	14.42	3.455	20.42	2.503
2.50	2.786	8.50	8.756	14.50	3.434	20.50	2.495
2.58	2.813	8.58	8.467	14.58	3.413	20.58	2.487
2.67	2.841	8.67	8.203	14.67	3.392	20.67	2.479
2.75	2.870	8.75	7.961	14.75	3.372	20.75	2.471
2.83	2.899	8.83	7.737	14.83	3.352	20.83	2.463
2.92	2.930	8.92	7.530	14.92	3.333	20.92	2.455
3.00	2.961	9.00	7.338	15.00	3.314	21.00	2.447
3.08	2.993	9.08	7.159	15.08	3.295	21.08	2.439
3.17	3.027	9.17	6.992	15.17	3.277	21.17	2.431
3.25	3.061	9.25	6.835	15.25	3.259	21.25	2.424
3.33	3.097	9.33	6.688	15.33	3.241	21.33	2.416
3.42	3.134	9.42	6.549	15.42	3.223	21.42	2.409
3.50	3.172	9.50	6.419	15.50	3.206	21.50	2.401
3.58	3.212	9.58	6.295	15.58	3.189	21.58	2.394
3.67	3.253	9.67	6.178	15.67	3.172	21.67	2.387
3.75	3.295	9.75	6.067	15.75	3.155	21.75	2.379
3.83	3.340	9.83	5.961	15.83	3.139	21.83	2.372
3.92	3.386	9.92	5.861	15.92	3.123	21.92	2.365
4.00	3.434	10.00	5.765	16.00	3.107	22.00	2.358
4.08	3.484	10.08	5.673	16.08	3.092	22.08	2.351
4.17	3.536	10.17	5.586	16.17	3.076	22.17	2.344
4.25	3.590	10.25	5.502	16.25	3.061	22.25	2.337
4.33	3.647	10.33	5.422	16.33	3.046	22.33	2.330
4.42	3.707	10.42	5.345	16.42	3.032	22.42	2.324
4.50	3.770	10.50	5.271	16.50	3.017	22.50	2.317
4.58	3.836	10.58	5.200	16.58	3.003	22.58	2.310
4.67	3.905	10.67	5.132	16.67	2.989	22.67	2.304
4.75	3.978	10.75	5.066	16.75	2.975	22.75	2.297
4.83	4.055	10.83	5.002	16.83	2.961	22.83	2.291
4.92	4.137	10.92	4.941	16.92	2.947	22.92	2.284
5.00	4.223	11.00	4.882	17.00	2.934	23.00	2.278
5.08	4.316	11.08	4.825	17.08	2.921	23.08	2.272
5.17	4.414	11.17	4.770	17.17	2.908	23.17	2.265
5.25	4.519	11.25	4.716	17.25	2.895	23.25	2.259
5.33	4.631	11.33	4.664	17.33	2.882	23.33	2.253
5.42	4.752	11.42	4.614	17.42	2.870	23.42	2.247
5.50	4.882	11.50	4.565	17.50	2.857	23.50	2.241
5.58	5.024	11.58	4.518	17.58	2.845	23.58	2.235
5.67	5.177	11.67	4.472	17.67	2.833	23.67	2.229
5.75	5.346	11.75	4.428	17.75	2.821	23.75	2.223
5.83	5.530	11.83	4.385	17.83	2.810	23.83	2.217
5.92	5.735	11.92	4.343	17.92	2.798	23.92	2.211
6.00	5.962	12.00	4.302	18.00	2.786	24.00	2.205

```
--------------------------------------------------------------------------------
001:0003----------------------------------------------------------------------------
********************************************************************************
*
*  Existing Site                                              Area=32.6 ha
*
********************************************************************************
----------------------
| CALIB NASHYD       |   Area    (ha)=   32.60   Curve Number    (CN)=74.00
```

```
| 01:EXSITE DT= 5.00 |   Ia      (mm)=   3.200   # of Linear Res.(N)= 2.00
----------------------   U.H. Tp(hrs)=  12.400

     Unit Hyd Qpeak  (cms)=     .068

     PEAK FLOW       (cms)=     .141 (i)
     TIME TO PEAK    (hrs)=   27.333
     RUNOFF VOLUME    (mm)=   56.881
     TOTAL RAINFALL   (mm)=  108.355
     RUNOFF COEFFICIENT   =     .525

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------------------
001:0004----------------------------------------------------------------------------------
**************************************************************************
*
*  Site                                              Area=64.5 ha
*
**************************************************************************
----------------------
| CALIB STANDHYD     |   Area    (ha)=   64.50
| 02:1      DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   70.00
----------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=      45.15         19.35
     Dep. Storage     (mm)=       1.60          3.20
     Average Slope     (%)=       1.00          2.00
     Length            (m)=     575.00         40.00
     Mannings n           =       .013          .250

     Max.eff.Inten.(mm/hr)=      29.65         10.64
               over (min)        12.00         29.00
     Storage Coeff.  (min)=      11.87 (ii)    29.16 (ii)
     Unit Hyd. Tpeak (min)=      12.00         29.00
     Unit Hyd. peak  (cms)=        .10           .04
                                                      *TOTALS*
     PEAK FLOW       (cms)=       3.03           .42          3.314 (iii)
     TIME TO PEAK    (hrs)=       7.38          7.83          7.400
     RUNOFF VOLUME    (mm)=     106.73         54.19         90.995
     TOTAL RAINFALL   (mm)=     108.35        108.35        108.355
     RUNOFF COEFFICIENT   =        .98           .50           .840

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  72.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------------------
001:0005----------------------------------------------------------------------------------
**************************************************************************
* ROUTE RESERVOIR - Storm Pond
* NWL=877.3
* HWL (Design) =878.4
* MAXIMUM HWL ELEVATION ESTIMATED AT
*
* SUB-CATCHMENTS:
* RELEASE RATE = 64.5 ha * 3.1 L/s/ha = 199.2 L/s
*
```

```
---------------------
| ROUTE RESERVOIR   |     Requested routing time step =  1.0 min.
|  IN>02:(1     )   |
| OUT<03:(000102)   |     =========  OUTLFOW STORAGE TABLE  =========
---------------------     OUTFLOW     STORAGE   |  OUTFLOW     STORAGE
                            (cms)     (ha.m.)   |    (cms)     (ha.m.)
                             .000  .0000E+00   |     .000  .3622E+01
                             .000  .1497E+01   |     .000  .4314E+01
                             .000  .1697E+01   |     .000  .4550E+01
                             .000  .2314E+01   |     .000  .6547E+01
                             .000  .2955E+01   |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >02: (1     )      64.50     3.314     7.400     90.995
     OUTFLOW<03: (000102)      64.50      .000      .000       .000

                  PEAK   FLOW   REDUCTION [Qout/Qin](%)=     .000
                  TIME SHIFT OF PEAK FLOW         (min)=  -444.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=.5869E+01

      *** WARNING: Outflow volume is less than inflow volume.
-------------------------------------------------------------------------------------------
001:0006-----------------------------------------------------------------------------------
*******************************************************************************
*  Pond Characteristics
*******************************************************************************
*    Description    Elevation    Depth      Area     Volume    Discharge
*                    (m)          (m)       (m2)       (m3)        (m3/s)
*                   878.00        -0.30       30600       0          0.0000
*      NWL          878.30        0.00        35215       0       0.0000
*                   878.70        0.40        39697       14973          0.0000
*                   878.75        0.45        40257       16972          0.0000
*                   878.90        0.60        41938       23136          0.0000
*                   879.05        0.75        43618       29553          0.0000
*                   879.20        0.90        45299       36221          0.0000
*                   879.35        1.05        46980       43142          0.0000
*      HWL          879.40        1.10        47540       45505       0.0000
*      FB           879.80        1.50        52300        65465       0.0000
*******************************************************************************
*
*
      FINISH
-------------------------------------------------------------------------------------------
*******************************************************************************************
     WARNINGS / ERRORS / NOTES
     -------------------------
 001:0005 ROUTE RESERVOIR
      *** WARNING: Outflow volume is less than inflow volume.
   Simulation ended on 2012-11-27     at 10:38:53
===========================================================================================
```

Appendix B – Forebay Sizing Calculations

Stantec Consulting
TES Industrail Site - Blackfalds
Stormwater Management Report, January 2012
Requirements as per City of Calgary and AENV Stormwater Guidelines

Forebay Characteristics:

(1)	42	Forebay Length at NWL (m)
(2)	21	Forebay Width at NWL (m)
(3)	2.0	Minimum length to width ratio of forebay (m)
(4)	1.5	Forebay depth at NWL (m)
(5)	0.257	Maximum discharge rate from facility (m^3/s)
(6)	2.000	Maximum inflow to facility (m^3/s)
(7)	0.0003	Design settling velocity (m/s)
(8)	0.5	Dispersion velocity at end of forebay (m/s)

Forebay Requirements:

$L_{settling} = [rQ_p/V_s]^{0.5} = [(3)x(5)/(7)]^{0.5} =$ **41.4** < 42 Adequately Sized

r = Length to width ratio of forebay

Q_p = Maximum discharge rate from facility during the design storm

V_s = Design settling velocity; dependent on the desired particle size to settle

$L_{dispersion} = (8Q)/(dV_f) = [8x(6)]/[(4)x(8)] =$ **21.3** < 42 Adequately Sized

Q = Maximum inflow to facility

d = Forebay depth at NWL

V_f = Dispersion velocity at end of forebay

$W = L_{dispersion} / 8$ **2.666667** < 21 Adequately Sized

W = Forebay bottom width