ATTACHMENT 2

PROPOSED STORMWATER MANAGEMENT FACILITY

January 25, 2018
MTE File No.: C33886-100

Mr. Lou Freymond
Freymond Lumber Ltd.
2287 Bay Lake Road, RR1
Bancroft, ON K0L 1C0

Dear Mr. Freymond:

Re: Freymond Quarry
Proposed Stormwater Management Facility

1.0 INTRODUCTION

The purpose of this memorandum is to address the potential impacts associated with discharging water from the proposed Freymond Quarry, located on part of Lots 51 & 52, Concession W.H.R., Township of Faraday, Concessions of Hastings, or 2287 Bay Lake Road, Bancroft, Ontario (hereafter referred to as the "Site").

The quarry lands are proposed to drain by gravity to a stormwater management pond located in the southeast corner of the Site, which is proposed to provide the required water quality and quantity control before discharging to an unnamed stream south of the Site (hereafter referred to as the "South Stream"), which flows east to the York River approximately 500 m downstream.

2.0 STORMWATER MANAGEMENT CRITERIA

The proposed stormwater management works shall be designed in accordance with the Ministry of Natural Resources and Forestry (MNRF) and the Ministry of the Environment and Climate Change (MOECC) *Stormwater Management Planning and Design Manual* (MOE, 2003). As the stormwater management facility is proposed to outlet to a stream system, water quality and erosion controls must be incorporated. Additionally, the stream crosses several access routes for the area, including Highway 62 going into the Town of Bancroft, so the stormwater management plan must include water quantity control to mitigate any potential flood hazard. The criteria for development of this stormwater management plan are therefore as follows:

- Provide an *Enhanced* (MOE, 2003) level of quality control,
- Provide 24 hour detention of the 25 mm 4-hour Chicago storm event for erosion control,
- Provide pre- to post-excavation peak flow matching for the 2 through 100-year return period storm events.

3.0 WATER QUALITY

The Ministry of Natural Resources and Forestry has specified that stormwater management facilities which outlet to the South Stream must provide an *Enhanced* level of quality control as described in Table 3.2 of the MOECC *Stormwater Management Planning and Design Manual* (MOE, 2003).

The Site is proposed to be excavated in 4 phases from the initial excavated condition to the final rehabilitated condition. The layout of the excavation, overburden stockpiling, existing and remediated vegetation, and stormwater management facility on the Site was provided in sketches to MTE from MHBC. The sketched areas were then quantified by MTE for design purposes. Both the initial and quantified sketches, as well as a table summarizing the hydrologic properties of each area, are included in the appendices. It was assumed that both the excavation and the overburden stockpiling areas would be completely impervious for this design; as there is very little overburden on-site to stockpile. As such, the potential exists for these areas to be completely exposed bedrock. Phase 3 of the development has the largest amount of open excavation and therefore the highest impervious value. For these reasons, it will be considered the 'design phase' for the purpose of this stormwater management plan.

During the most intense phase of excavation (Phase 3), the Site has an imperviousness of approximately 55.5% over its 33.27 ha area. With these parameters, the design of a wet pond facility requires a permanent pool volume of 5,032 m^3 and an extended detention storage volume of 1,331 m^3, the latter of which is to be retained for a minimum of 24 hours (MOE, 2003). The proposed stormwater management facility has a permanent pool volume of 7,680 m^3, sufficient for the subject site. General facility details, including quality control, are outlined in **Table 1** below.

4.0 EROSION CONTROL

Erosion control will be provided as per the MOECC manual by ensuring that the volume of the 25 mm 4-hour Chicago design storm event will be retained in the stormwater management facility for a minimum of 24 hours (MOE, 2003).

Design storm event modelling for the Site was performed using MIDUSS (version 2.25 revision 473) software and is included in the appendices. Rainfall Intensity-Duration-Frequency (IDF) data was obtained from the Ontario Ministry of Transportation (MTO) IDF curve lookup application for the Bancroft area, which was then used (in conjunction with the MIDUSS IDF curve fit tool) to create Chicago design storm parameters for the 2 through 100-year return period events. Chicago design storm parameters for the 25 mm event is based on the 2-year return period with a lowered "A" coefficient to obtain the desired 25 mm total rainfall depth. The total volume of the 25 mm event during the design extraction phase is 4,392 m^3. Information on the IDF parameters is included in the appendices.

5.0 WATER QUANTITY

In order to mitigate downstream flooding considerations, post-excavation peak flows into the South Stream will be controlled to pre-excavation levels for the 2 through 100-year return period events. As previously discussed, Chicago design storm parameters were derived using the MTO IDF curve lookup application for the Bancroft area. Information on the pre-excavation catchment area draining to the South Stream (catchment 104, as detailed in **Figure 14: Drainage Assessment – Existing Conditions**) is included in the appendices, along with catchment parameters for each of the excavation phases. The pre- and post-excavation MIDUSS modelling is also included in the appendices; the results of which are summarized in **Table 2** below.

Though the Site is proposed to be remediated after the extraction is complete, there will always be an increased drainage area directed to the South Stream (catchment 504 as illustrated on **Figure 18: Drainage Assessment – Phase 4**). As such, the stormwater management pond is proposed to remain in the remediated condition to continue to provide peak flow attenuation and erosion control to the South Stream. Additional flow due to groundwater seepage from the excavation is assumed to be negligible.

6.0 STORMWATER MANAGEMENT FACILITY DESIGN

6.1 Facility Outlet

As described in **Sections 3.0 & 4.0** above, both the 1,331 m^3 MOECC water quality volume and the 4,392 m^3 25 mm storm event volume must be retained for a minimum of 24 hours. It is the smaller MOECC quality volume which limits the maximum size of the extended detention orifice. An orifice drawdown design sheet is included in the appendices and indicates that based on the pond geometry; a 100 mm diameter orifice may be used to provide minimum 24-hour extended detention for the aforementioned volumes. The extended detention outlet control is therefore proposed to be a 100 mm diameter orifice with its invert set at the permanent pool elevation of 332.00 m to ensure adequate fall exists to the South Stream. The peak extended detention ponding elevation occurs for the larger 25 mm event volume and is 332.68 m, as outlined in **Table 1**.

In order to provide quantity control for larger storm events as described in **Section 5.0**, a 1.25 m horizontal weir is proposed at an elevation of 332.70 m, which is above the extended detention storage levels. The peak ponding elevation and storage volume for each design storm are shown in **Table 2**.

The weir, along with the aforementioned orifice, is proposed to be located within a precast concrete box manhole as illustrated on **MTE Figure 19: Stormwater Management Facility**. The 1.25 m quantity control weir is to be located at the top of the weir wall, at an elevation of 332.70 m as specified on the drawing. The top of the precast box manhole outlet structure is to be open, covered by galvanized ditch inlet grating, and set at an elevation of 333.40 m. The purpose of the open top outlet structure is to provide an emergency overflow outlet above the maximum modelled ponding elevations.

TABLE 1: Stormwater Management Facility Design Characteristics

General	Facility Characteristics
Stormwater Management Facility Type	Wet Pond
Required MOECC Water Quality Protection	Level 1 (Enhanced)
Total Contributing Area	33.27 ha
Imperviousness	55.53%
Bottom Elevation (of main facility)	329.00 m
Storage	
Unit Area Storage Volume Requirements as per SWMMP (MOE 2003)	191.24 m^3/ha
Required Total Volume	6,363 m^3
Permanent Pool	
Required Permanent Pool Volume	5,032 m^3
Provided Permanent Pool Volume	7,680 m^3
Permanent Pool Elevation	332.00 m
Extended Detention	
Minimum Required Volume	25 mm Event
Approximate Drawdown Time (for MOECC Table 3.2 requirement)	71.0 hr
Extended Detention Elevation (for 25 mm event)	332.68 m
Peak Release Rate for Extended Detention (for 25 mm event)	0.017 m^3/s
Settling	
Required Settling Length	77 m
Provided Settling Length	90 m
Outlet Controls	
Precast Concrete Box Manhole Outlet Structure	
Orifice 1 Diameter (Extended Detention)	100 mm
Orifice 1 Invert Elevation (Extended Detention)	332.00m
Weir 1 Crest (Quantity Control)	1.25 m
Weir 1 Side Slopes (Quantity Control)	Vertical
Weir 1 Elevation (Quantity Control)	332.70 m

TABLE 2: MIDUSS Modelling Summary

Storm Event	Pre-Excavation Peak Flow (m^3/s)	Pre-Excavation Runoff Volume (m^3)	Post-Excavation Pond Inflow (m^3/s)	Post-Excavation Runoff Volume (m^3)	Post-Excavation Pond Outflow (m^3/s)	Required Storage Volume (m^3)	Peak Ponding Elevation (m)
25 mm	0.098	1333	2.709	4392	0.017	4062	332.68
2 Year	0.169	1765	3.414	5220	0.064	4682	332.78
5 Year	0.421	3260	4.829	7758	0.288	5961	332.97
10 Year	0.653	4385	5.738	9494	0.443	6617	333.06
25 Year	0.982	5972	6.759	11787	0.680	7494	333.19
50 Year	1.314	7124	7.603	13370	0.873	8138	333.28
100 Year	1.639	8438	8.477	15110	1.098	8845	333.38

The box manhole will outlet directly to a 900 mm diameter Smooth Wall Boss HDPE pipe at a minimum 0.5% slope; sufficient to convey the peak facility outflow of 1.098 m^3/s to the South Stream. Approximately, 87.1 m of pipe will be installed until its spring line emerges from the embankment to the South Stream, at which point the pipe will be terminated and a rip-rap lined energy dissipation pad shall be graded into the embankment to reduce the effects of erosion. Refer to **MTE Figure 19: Stormwater Management Facility** for more details.

6.2 Settling Length

Since the majority of annual rainfall occurs in storms less than or equal to the 25 mm storm event, the majority of water borne sediment is also transported to the stormwater management facilities in these less intense events[1]. Therefore, the facility has been designed using a berm with an elevation of 332.70 m to provide a long settling length for the 25 mm event and target these smaller flows, while allowing the upper portions of the facility to provide unimpeded storage and a greater area of flow for the more intense storm events.

The facility design is based on classic particle settling and flow dispersion equations as presented in the MOECC *Stormwater Management Practices Planning and Design Manual* (MOE, 1994). The design flow for the settling length was taken to be the peak outflow from the facility during the 25 mm event. Furthermore, the settling velocity was assumed to be 0.00001300 m/s in order to ensure the settling of particles >20 µm (MOE, 1994). Additionally, flow dispersion and scour velocity checks were made, including the permanent pool area, to ensure that sufficient length is provided to mitigate all concerns. The required settling length was calculated to be 77 m, whereas approximately 90 m of settling length is provided in the pond. Settling calculations are included in the appendices.

6.3 Additional Features

The following additional features have been incorporated into the stormwater management facility design:

- The permanent pool will be excavated to 3 m where possible to provide additional settling volume and reduce cleanout frequency;
- The maximum active storage retention depth has been limited to 1.5 m;
- For safety, side slopes have been limited to 4:1 for 3 m below the permanent pool, and 3:1 for 1.5 m above the permanent pool;
- A minimum 3 m wide and 0.3 m deep flat shelf is proposed around the perimeter of the permanent pool elevation to serve as a wetland planting area;
- An access & maintenance road of 4 m width has been incorporated into the design to ensure sufficient access to the outlet structures and pond bottom for ease of inspection and maintenance. The access road will have a maximum longitudinal slope of 10:1 and a minimum inside radius of curvature of 10 m; and,
- As this pond will be constructed below the groundwater level, an impermeable (geotextile or clay) pond liner may be required.

1. From MOE-1994, Figure C.1: 54% less than 5mm, 75% < 10mm, 93% < 15mm and 99% < 25mm

7.0 MONITORING PROGRAM

Effluent from the SWM facility shall be sampled monthly under non-freezing conditions, after significant rainfall events (>8 mm), provided that there are sufficient volumes of water to be sampled, for a period of two years after operations commence, as specified below:

- Samples are to be analyzed for the following parameters:
    a) Total Suspended Solids (TSS).
    b) Total Ammonia.
    c) Total Petroleum Hydrocarbons (fractions F1 through F4).
- During sampling, the pH and temperature of the water sample will be collected and recorded in-situ. The concentration of un-ionized ammonia shall be calculated using the total ammonia concentration, pH, and temperature using the methodology stipulated in "Ontario's Provincial Water Quality Objectives" dated July 1994, as amended, for ammonia (un-ionized).
- The quarry operator shall measure, record, and calculate the volume of flow discharging over the control structure on each day of sampling.
- After two years of operations, the effluent monitoring program shall be reviewed on an annual basis and revised if necessary.

8.0 CONCLUSIONS & RECOMMENDATIONS

Based on the foregoing analyses, it is concluded that:

- The described stormwater management facility will provide adequate quality and flood control measures for stormwater runoff from the Site to the South Stream; and,
- The described stormwater management facility will provide best management practices for erosion control based on MOECC guidelines.

These conclusions lead to the following recommendations:

- That a fluvial geomorphological assessment of the South Stream be performed in order to establish specific erosion control criteria;
- That the facility design be reviewed in conjunction with the updated *Environmental Impact Statement* when it becomes available, specifically with respect to any mitigation measures for the South Stream;
- That the stormwater management facility be constructed as described in this memo, including the specified outlet, settling length, and impermeable pond liner;
- That the extraction operator may not at any point exceed the total disturbed area and/or area of exposed bedrock face assumed for the design phase of the stormwater management facility, as described in **Section 3.0**;
- That the facility effluent be monitored as described in **Section 7.0** to verify facility performance; and,
- That the facility remain in the rehabilitated condition to continue to provide peak flow attenuation and erosion control for the South Stream.

We trust the above and enclosed is in order, if you wish to discuss further, please do not hesitate to contact the undersigned.

Yours truly,

MTE CONSULTANTS INC.

Charles Carré, E.I.T.
Designer

Jeff Martens, P. Eng.
Design Engineer

cc: Mr. Jay Flanagan, MTE Consultants Inc.
Mr. Robin E. Craig, Environmental Consultant, Certified Wildlife Biologist

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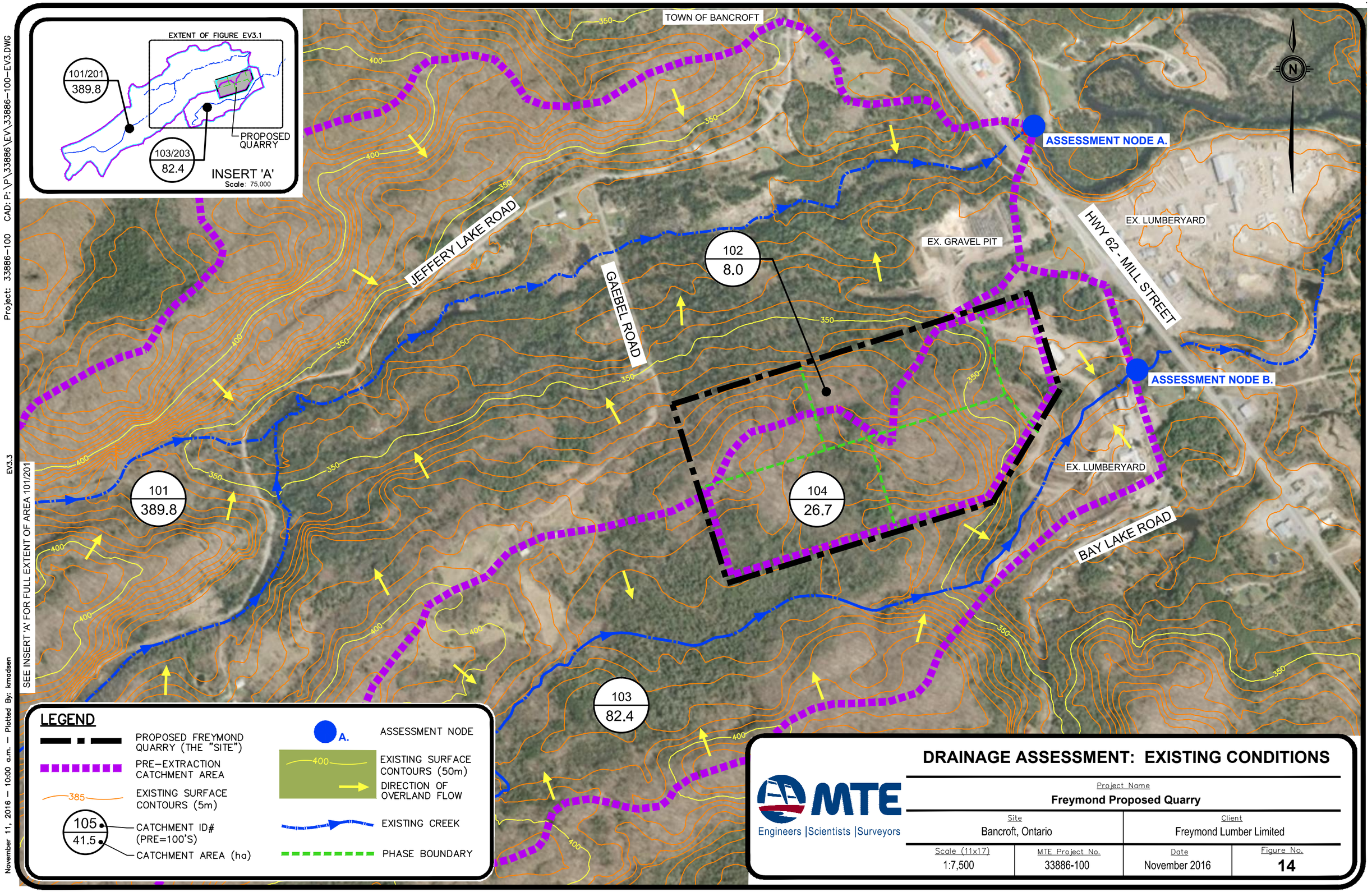
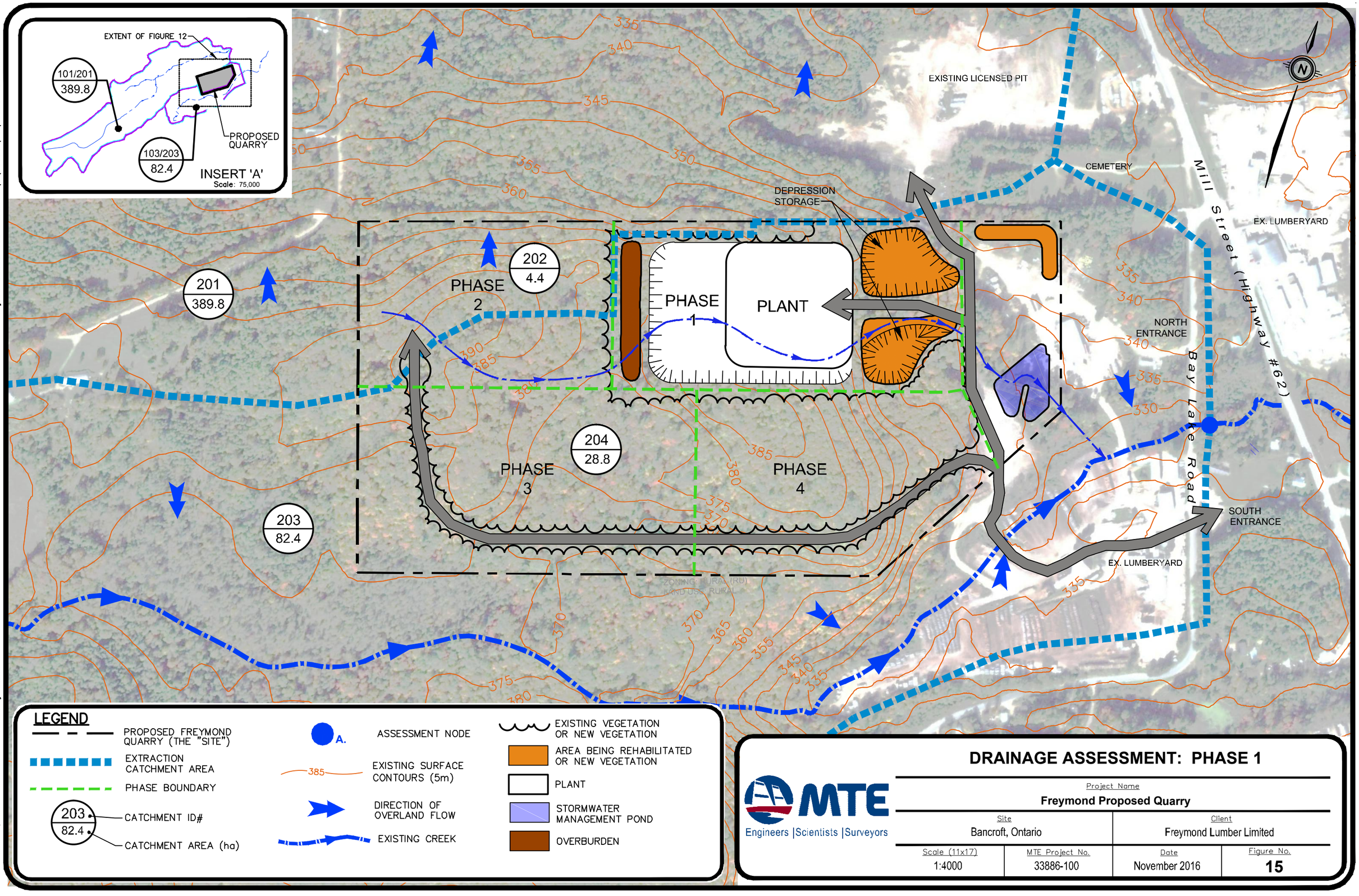


DRAINAGE ASSESSMENT: EXISTING CONDITIONS

MTE Engineers | Scientists | Surveyors

Project Name			
Freymond Proposed Quarry			
Site: Bancroft, Ontario		Client: Freymond Lumber Limited	
Scale (11x17): 1:7,500	MTE Project No.: 33886-100	Date: November 2016	Figure No.: 14



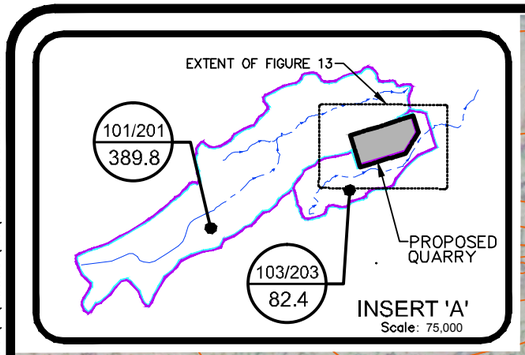
Project: 33886-100 CAD: P:\P\33886\EV\33886-100-EV13.DWG EV13.1 June 22, 2017 – 9:10 a.m. – Plotted By: ccarre

Engineers | Scientists | Surveyors

DRAINAGE ASSESSMENT: PHASE 1

Project Name			
Freymond Proposed Quarry			
Site		Client	
Bancroft, Ontario		Freymond Lumber Limited	
Scale (11x17)	MTE Project No.	Date	Figure No.
1:4000	33886-100	November 2016	15

Project: 33886-100 CAD: P:\P\33886\EV\33886-100-EV14.DWG EV14.1 June 22, 2017 - 9:15 a.m. - Plotted By: ccarre



302
1.2

301
389.8

303
82.4

304
32.0

PHASE 2

PLANT

PHASE 3

PHASE 4

DEPRESSION STORAGE

ZONING: RURAL (RU)
LAND USE: RURAL

Cemetery

Mill Street (Highway #62)

EX. LUMBERYARD

NORTH ENTRANCE

Bay Lake Road

SOUTH ENTRANCE

EX. LUMBERYARD

335 340 345 350 355 360 365 370 375 380 385

LEGEND

- PROPOSED FREYMOND QUARRY (THE "SITE")
- EXTRACTION CATCHMENT AREA
- PHASE BOUNDARY
- 303 / 82.5 — CATCHMENT ID# / CATCHMENT AREA (ha)
- A. — ASSESSMENT NODE
- 385 — EXISTING SURFACE CONTOURS (5m)
- DIRECTION OF OVERLAND FLOW
- EXISTING CREEK
- EXISTING VEGETATION OR NEW VEGETATION
- AREA BEING REHABILITATED OR NEW VEGETATION
- PLANT
- STORMWATER MANAGEMENT POND
- OVERBURDEN

MTE
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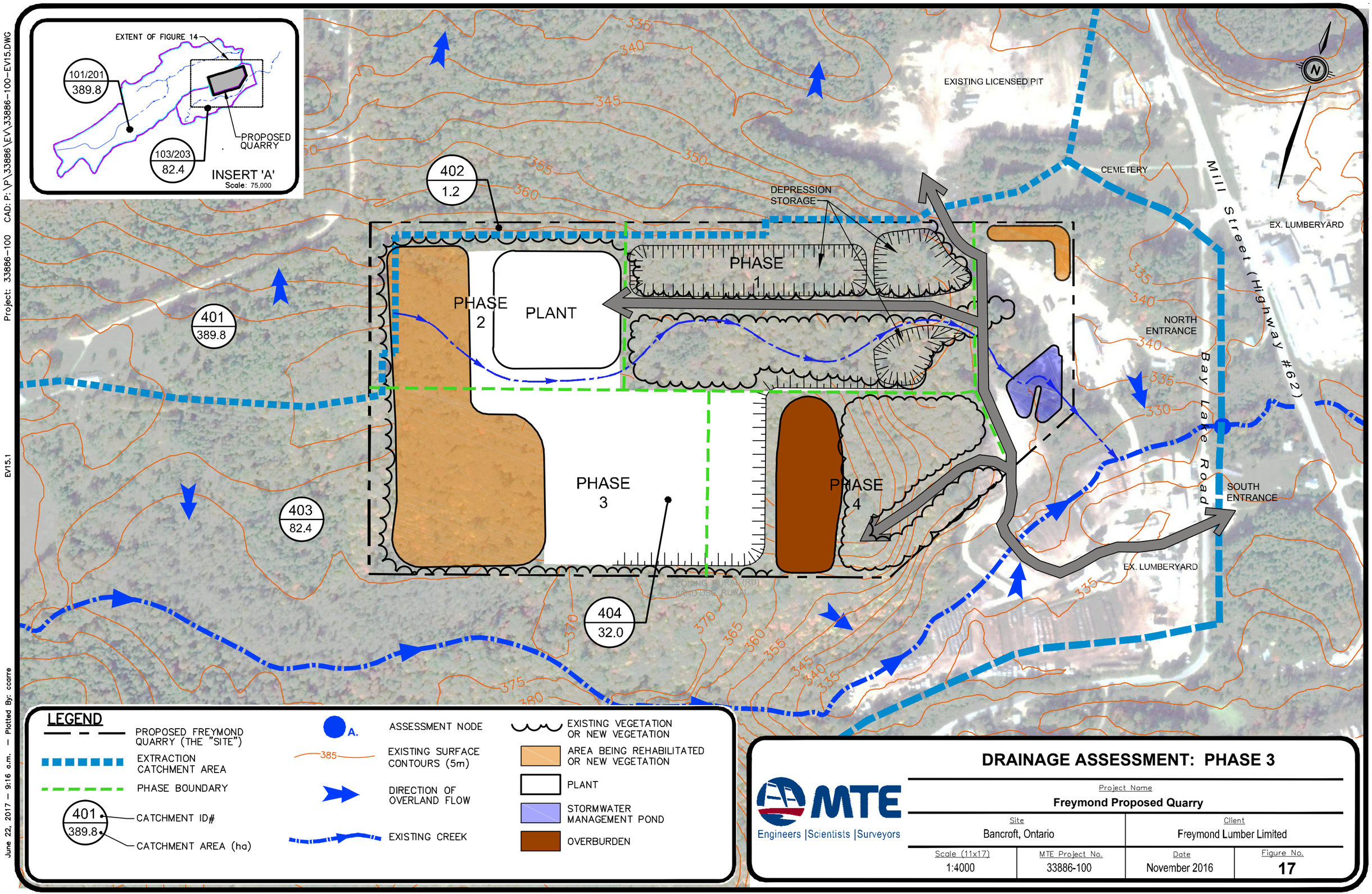
DRAINAGE ASSESSMENT: PHASE 2

Project Name			
Freymond Proposed Quarry			
Site: Bancroft, Ontario		Client: Freymond Lumber Limited	
Scale (11x17): 1:4000	MTE Project No.: 33886-100	Date: November 2016	Figure No.: 16



LEGEND

- PROPOSED FREYMOND QUARRY (THE "SITE")
- EXTRACTION CATCHMENT AREA
- PHASE BOUNDARY
- 401 / 389.8 — CATCHMENT ID# / CATCHMENT AREA (ha)
- A. — ASSESSMENT NODE
- 385 — EXISTING SURFACE CONTOURS (5m)
- DIRECTION OF OVERLAND FLOW
- EXISTING CREEK
- EXISTING VEGETATION OR NEW VEGETATION
- AREA BEING REHABILITATED OR NEW VEGETATION
- PLANT
- STORMWATER MANAGEMENT POND
- OVERBURDEN

DRAINAGE ASSESSMENT: PHASE 3

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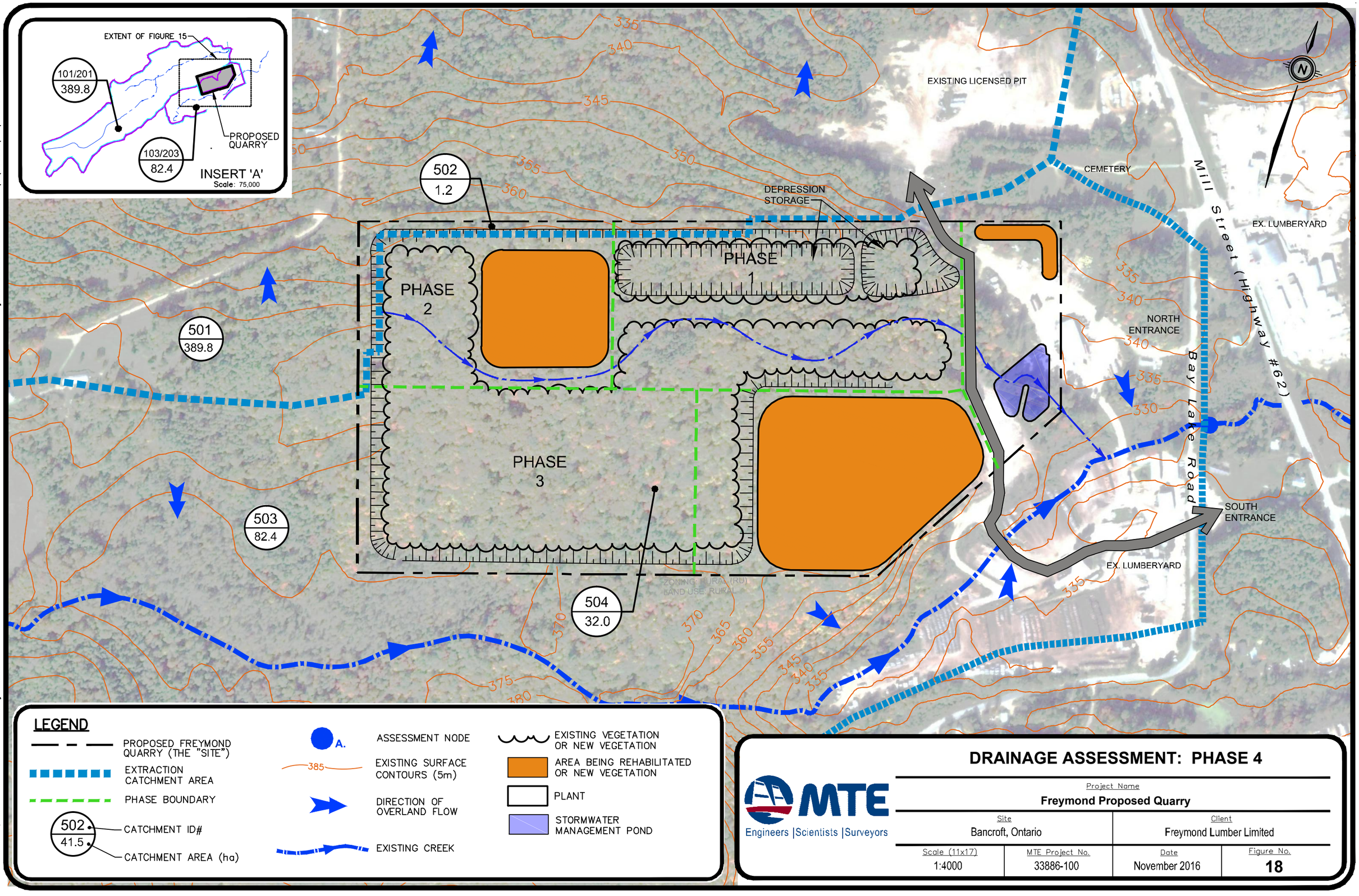
Project Name			
Freymond Proposed Quarry			
Site: Bancroft, Ontario		Client: Freymond Lumber Limited	
Scale (11x17): 1:4000	MTE Project No.: 33886-100	Date: November 2016	Figure No.: 17



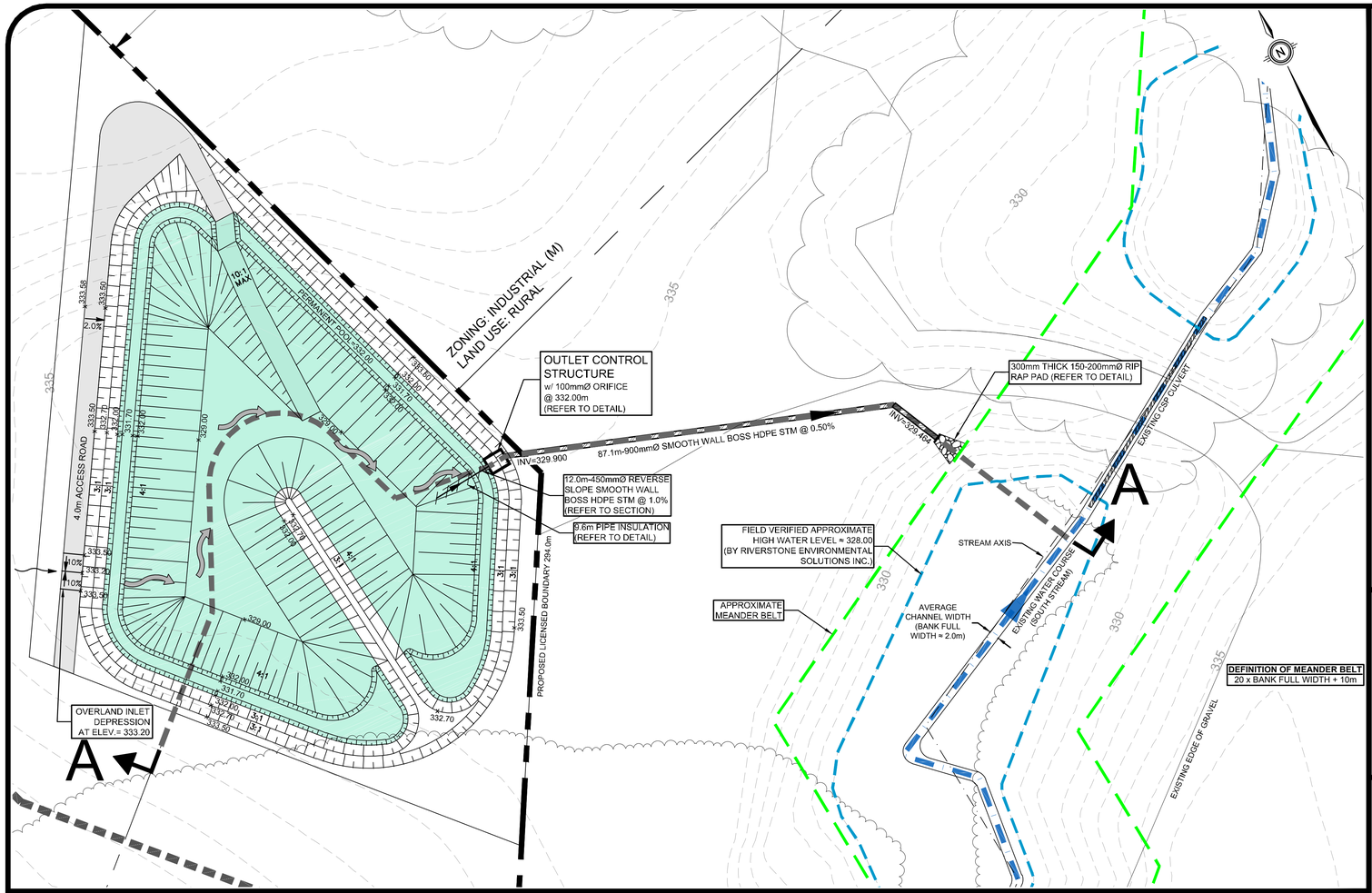
LEGEND

- PROPOSED FREYMOND QUARRY (THE "SITE")
- EXTRACTION CATCHMENT AREA
- PHASE BOUNDARY
- 502 / 41.5 — CATCHMENT ID# / CATCHMENT AREA (ha)
- A. — ASSESSMENT NODE
- 385 — EXISTING SURFACE CONTOURS (5m)
- DIRECTION OF OVERLAND FLOW
- EXISTING CREEK
- EXISTING VEGETATION OR NEW VEGETATION
- AREA BEING REHABILITATED OR NEW VEGETATION
- PLANT
- STORMWATER MANAGEMENT POND

DRAINAGE ASSESSMENT: PHASE 4

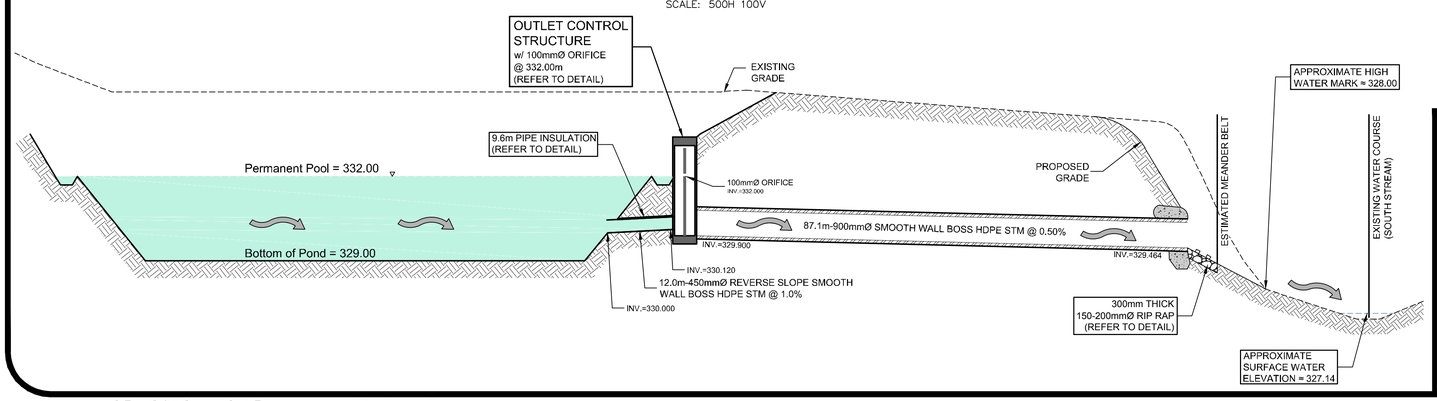
MTE Engineers | Scientists | Surveyors

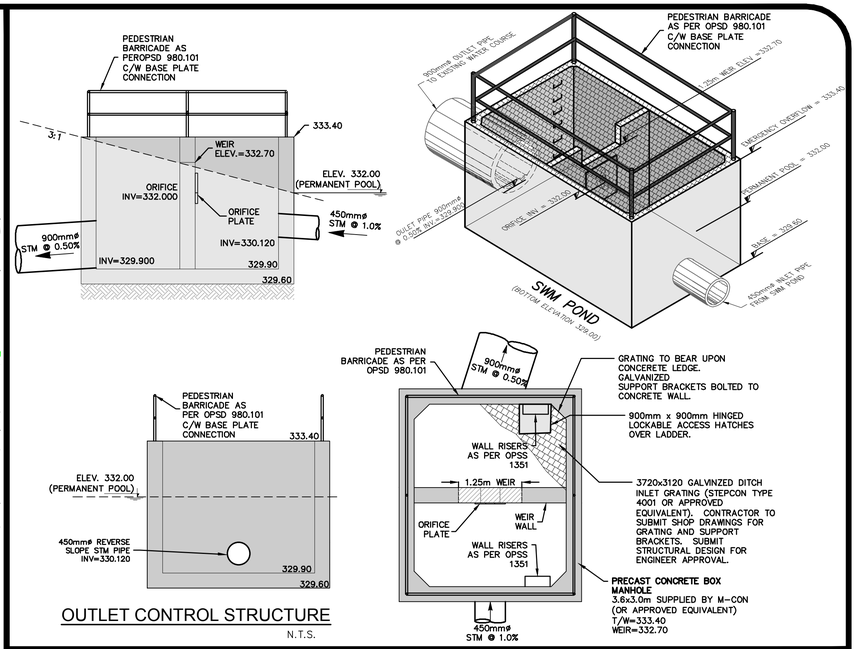
Project Name			
Freymond Proposed Quarry			
Site: Bancroft, Ontario		Client: Freymond Lumber Limited	
Scale (11x17): 1:4000	MTE Project No.: 33886-100	Date: November 2016	Figure No.: 18

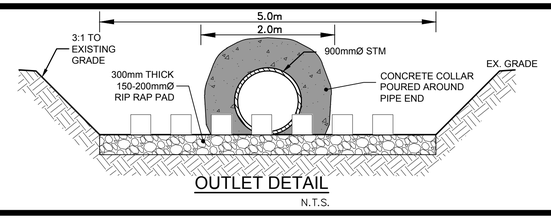


SECTION A-A

SCALE: 500H 100V

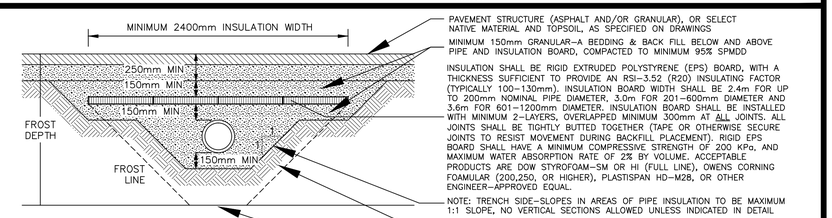






OUTLET DETAIL

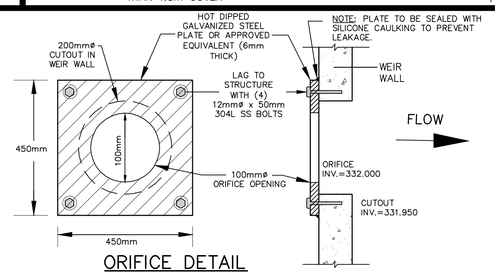
N.T.S.



SEWER PIPE INSULATION DETAIL

FOR SEWER PIPES HAVING LESS THAN 1.5m COVER

N.T.S.



ORIFICE DETAIL

N.T.S.

FIGURE 19.0 Date: JAN.25/18 Scale: 1:500

FREYMOND QUARRY STORMWATER MANAGEMENT FACILITY

MTE Engineers | Scientists | Surveyors

Project No.: 33886-100

FREYMOND QUARRY
STORMWATER MANAGEMENT
Bancroft, Ontario

Project Number: 33886-100
Date: June 20, 2017
Designer: KMR/CJC
File: Q:\33886\Micro Drainage Analysis\SWM\SWM Update - June 2017\33886-100 SWM Design-June 2017.xlsx

LAND USE CHARACTERISTICS

	SCS Curve Number			%
	AMC II	AMC III	Imp.	Imp.
Existing Vegetation	81	91	98	0
New Vegetation	81	91	98	15
Rehabilitation/Overburden	81	91	98	100
Excavation/Plant	N/A	N/A	98	100
Stormwater Management	81	91	98	50

LAND USE BY STAGE

	Land Use																						
	Existing Vegetation				New Vegetation				Rehabilitation/Overburden				Excavation/Plant				Stormwater Management				TOTAL (area weighted)		
	Area (ha)	Length (m)	Width (m)	Slope (%)	Area (ha)	Length (m)	Width (m)	Slope (%)	Area (ha)	Length (m)	Width (m)	Slope (%)	Area (ha)	Length (m)	Width (m)	Slope (%)	Area (ha)	Length (m)	Width (m)	Slope (%)	Area (ha)	Imp. (%)	Slope (%)
Pre-Excavation	28.88	810	420	7.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28.88	0.00	7.5
Stage 1	22.47	810	420	7.5	0	0	0	0	5.09	250	200	2	4.75	250	200	1	0.96	120	110	33	33.27	31.02	6.5
Stage 2	14.62	810	220	7.5	4.29	250	200	2	8.23	400	255	2	5.17	240	215	1	0.96	120	110	33	33.27	43.65	5.2
Stage 3 (Design Stage)	5.95	235	220	7.5	9.84	535	200	2	7.53	390	200	2	8.99	390	255	1	0.96	120	110	33	33.27	55.53	3.6
Stage 4	2.8	810	15	7.5	21.46	810	390	2	8.05	185	160	2	0	0	0	0	0.96	120	110	33	33.27	35.31	3.4

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19 "        0.695   Exponent C"
20 "        0.400   Fraction R"
21 "      240.000   Duration"
22 "        1.000   Time step multiplier"
23 "             Maximum intensity            88.577    mm/hr"
24 "             Total depth                  25.008    mm"
25 "            5   25hyd   Hydrograph extension used in this file"
26 " 33          CATCHMENT 200"
27 "            1   Triangular SCS"
28 "            1   Equal length"
29 "            1   SCS method"
30 "          200   Site Post-Excavation"
31 "       55.530   % Impervious"
32 "       33.270   Total Area"
33 "      195.000   Flow length"
34 "        3.600   Overland Slope"
35 "       14.795   Pervious Area"
36 "      195.000   Pervious length"
37 "        3.600   Pervious slope"
38 "       18.475   Impervious Area"
39 "      195.000   Impervious length"
40 "        3.600   Impervious slope"
41 "        0.250   Pervious Manning 'n'"
42 "       81.000   Pervious SCS Curve No."
43 "        0.185   Pervious Runoff coefficient"
44 "        0.100   Pervious Ia/S coefficient"
45 "        5.958   Pervious Initial abstraction"
46 "        0.015   Impervious Manning 'n'"
47 "       98.000   Impervious SCS Curve No."
48 "        0.803   Impervious Runoff coefficient"
49 "        0.100   Impervious Ia/S coefficient"
50 "        0.518   Impervious Initial abstraction"
51 "                    2.709     0.000     0.000     0.000 c.m/sec"
52 "             Catchment 200          Pervious   Impervious Total Area "
53 "             Surface Area           14.795     18.475     33.270     hectare"
54 "             Time of concentration  68.494     6.293      15.964     minutes"
55 "             Time to Centroid       243.683    131.293    148.767    minutes"
56 "             Rainfall depth         25.008     25.008     25.008     mm"
57 "             Rainfall volume        3699.90    4620.10    8320.00    c.m"
58 "             Rainfall losses        20.393     4.935      11.809     mm"
59 "             Runoff depth           4.615      20.073     13.199     mm"
60 "             Runoff volume          682.74     3708.41    4391.15    c.m"
61 "             Runoff coefficient     0.185      0.803      0.528      "
62 "             Maximum flow           0.061      2.700      2.709      c.m/sec"
63 " 40          HYDROGRAPH Add Runoff "
64 "            4   Add Runoff "
```



```
65 "                    2.709     2.709     0.000     0.000"
66 " 54          POND DESIGN"
67 "        2.709   Current peak flow    c.m/sec"
68 "        0.098   Target outflow    c.m/sec"
69 "       4391.1   Hydrograph volume    c.m"
70 "          16.   Number of stages"
71 "      332.000   Minimum water level    metre"
72 "      333.500   Maximum water level    metre"
73 "      332.000   Starting water level    metre"
74 "            0   Keep Design Data: 1 = True; 0 = False"
75 "                  Level Discharge    Volume"
76 "               332.000     0.000     0.000"
77 "               332.100   0.00400   561.000"
78 "               332.200   0.00800  1134.000"
79 "               332.300   0.01059  1720.000"
80 "               332.400   0.01265  2318.000"
81 "               332.500   0.01443  2928.000"
82 "               332.600   0.01601  3551.000"
83 "               332.700   0.01744  4187.000"
84 "               332.800   0.07940  4840.000"
85 "               332.900    0.1915  5508.000"
86 "               333.000    0.3363  6186.000"
87 "               333.100    0.5075  6874.000"
88 "               333.200    0.7015  7572.000"
89 "               333.300    0.9157  8281.000"
90 "               333.400     1.149  9000.000"
91 "               333.500     1.399  9730.000"
92 "           1.   WEIRS"
93 "                  Crest      Weir     Crest      Left     Right"
94 "              elevation coefficie   breadth sideslope sideslope"
95 "                332.700     0.900     1.250     0.000     0.000"
96 "           1.   ORIFICES"
97 "                Orifice   Orifice   Orifice Number of"
98 "                 invert coefficie  diameter  orifices"
99 "                332.000     0.630    0.1000     1.000"
100 "             Peak outflow                  0.017    c.m/sec"
101 "             Maximum level               332.680    metre"
102 "             Maximum storage            4061.566    c.m"
103 "             Centroidal lag               47.961   hours"
104 "                  2.709     2.709     0.017     0.000 c.m/sec"
105 " 38          START/RE-START TOTALS 200"
106 "            3   Runoff Totals on EXIT"
107 "             Total Catchment area                     33.270    hectare"
108 "             Total Impervious area                    18.475    hectare"
109 "             Total % impervious                       55.530"
110 " 19          EXIT"
```

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 1 "               MIDUSS Output ------------------------------------------------>"
 2 "               MIDUSS version                          Version 2.25  rev. 473"
 3 "               MIDUSS created                       Sunday, February 07, 2010"
 4 "           10  Units used:                                        ie METRIC"
 5 "               Job folder:              Q:\33886\Micro Drainage Analysis\SWM\"
 6 "                                                SWM Update - June 2017\MIDUSS"
 7 "               Output filename:                         33886-100-POST-2y.out"
 8 "               Licensee name:                                           MTE"
 9 "               Company                                   MTE Consultants Inc."
10 "               Date & Time last used:                 6/21/2017 at 3:23:33 PM"
11 " 31          TIME PARAMETERS"
12 "        5.000   Time Step"
13 "      240.000   Max. Storm length"
14 "     1500.000   Max. Hydrograph"
15 " 32          STORM Chicago storm"
16 "            1   Chicago storm"
17 "      348.960   Coefficient A"
18 "        0.116   Constant B"
19 "        0.695   Exponent C"
20 "        0.400   Fraction R"
21 "      180.000   Duration"
22 "        1.000   Time step multiplier"
23 "             Maximum intensity           112.220    mm/hr"
24 "             Total depth                  28.333    mm"
25 "            6   002hyd   Hydrograph extension used in this file"
26 " 33          CATCHMENT 200"
27 "            1   Triangular SCS"
28 "            1   Equal length"
29 "            1   SCS method"
30 "          200   Site Post-Excavation"
31 "       55.530   % Impervious"
32 "       33.270   Total Area"
33 "      195.000   Flow length"
34 "        3.600   Overland Slope"
35 "       14.795   Pervious Area"
36 "      195.000   Pervious length"
37 "        3.600   Pervious slope"
38 "       18.475   Impervious Area"
39 "      195.000   Impervious length"
40 "        3.600   Impervious slope"
41 "        0.250   Pervious Manning 'n'"
42 "       81.000   Pervious SCS Curve No."
43 "        0.216   Pervious Runoff coefficient"
44 "        0.100   Pervious Ia/S coefficient"
45 "        5.958   Pervious Initial abstraction"
46 "        0.015   Impervious Manning 'n'"
47 "       98.000   Impervious SCS Curve No."
48 "        0.825   Impervious Runoff coefficient"
49 "        0.100   Impervious Ia/S coefficient"
50 "        0.518   Impervious Initial abstraction"
51 "                    3.414     0.000     0.000     0.000 c.m/sec"
52 "             Catchment 200          Pervious   Impervious Total Area "
53 "             Surface Area           14.795     18.475     33.270     hectare"
54 "             Time of concentration  58.870     5.698      14.904     minutes"
55 "             Time to Centroid       187.255    99.633     114.803    minutes"
56 "             Rainfall depth         28.333     28.333     28.333     mm"
57 "             Rainfall volume        4191.87    5234.42    9426.29    c.m"
58 "             Rainfall losses        22.225     4.972      12.644     mm"
59 "             Runoff depth           6.108      23.361     15.689     mm"
60 "             Runoff volume          903.70     4315.94    5219.64    c.m"
61 "             Runoff coefficient     0.216      0.825      0.554      "
62 "             Maximum flow           0.105      3.397      3.414      c.m/sec"
63 " 40          HYDROGRAPH Add Runoff "
64 "            4   Add Runoff "
```



```
65 "                    3.414     3.414     0.000     0.000"
66 " 54          POND DESIGN"
67 "        3.414   Current peak flow    c.m/sec"
68 "        0.169   Target outflow    c.m/sec"
69 "       5219.6   Hydrograph volume    c.m"
70 "          16.   Number of stages"
71 "      332.000   Minimum water level    metre"
72 "      333.500   Maximum water level    metre"
73 "      332.000   Starting water level    metre"
74 "            0   Keep Design Data: 1 = True; 0 = False"
75 "                  Level Discharge    Volume"
76 "                332.000     0.000     0.000"
77 "                332.100   0.00400   561.000"
78 "                332.200   0.00800  1134.000"
79 "                332.300   0.01059  1720.000"
80 "                332.400   0.01265  2318.000"
81 "                332.500   0.01443  2928.000"
82 "                332.600   0.01601  3551.000"
83 "                332.700   0.01744  4187.000"
84 "                332.800   0.07940  4840.000"
85 "                332.900    0.1915  5508.000"
86 "                333.000    0.3363  6186.000"
87 "                333.100    0.5075  6874.000"
88 "                333.200    0.7015  7572.000"
89 "                333.300    0.9157  8281.000"
90 "                333.400     1.149  9000.000"
91 "                333.500     1.399  9730.000"
92 "           1.   WEIRS"
93 "                  Crest      Weir     Crest      Left     Right"
94 "              elevation coefficie   breadth sideslope sideslope"
95 "                332.700     0.900     1.250     0.000     0.000"
96 "           1.   ORIFICES"
97 "                Orifice   Orifice   Orifice Number of"
98 "                 invert coefficie  diameter  orifices"
99 "                332.000     0.630    0.1000     1.000"
100 "             Peak outflow                  0.064    c.m/sec"
101 "             Maximum level               332.776    metre"
102 "             Maximum storage            4682.029    c.m"
103 "             Centroidal lag               43.940   hours"
104 "                  3.414     3.414     0.064     0.000 c.m/sec"
105 " 38          START/RE-START TOTALS 200"
106 "            3   Runoff Totals on EXIT"
107 "             Total Catchment area                     33.270    hectare"
108 "             Total Impervious area                    18.475    hectare"
109 "             Total % impervious                       55.530"
110 " 19          EXIT"
```

```
 1 "               MIDUSS Output ------------------------------------------------>"
 2 "               MIDUSS version                          Version 2.25  rev. 473"
 3 "               MIDUSS created                       Sunday, February 07, 2010"
 4 "          10   Units used:                                        ie METRIC"
 5 "               Job folder:              Q:\33886\Micro Drainage Analysis\SWM\"
 6 "                                                SWM Update - June 2017\MIDUSS"
 7 "               Output filename:                         33886-100-POST-5y.out"
 8 "               Licensee name:                                           MTE"
 9 "               Company                                   MTE Consultants Inc."
10 "               Date & Time last used:                 6/21/2017 at 3:24:49 PM"
11 " 31          TIME PARAMETERS"
12 "        5.000   Time Step"
13 "      240.000   Max. Storm length"
14 "     1500.000   Max. Hydrograph"
15 " 32          STORM Chicago storm"
16 "           1   Chicago storm"
17 "      464.780   Coefficient A"
18 "        0.019   Constant B"
19 "        0.693   Exponent C"
20 "        0.400   Fraction R"
21 "      180.000   Duration"
22 "        1.000   Time step multiplier"
23 "             Maximum intensity           151.957    mm/hr"
24 "             Total depth                  38.145    mm"
25 "           6   005hyd   Hydrograph extension used in this file"
26 " 33          CATCHMENT 200"
27 "           1   Triangular SCS"
28 "           1   Equal length"
29 "           1   SCS method"
30 "         200   Site Post-Excavation"
31 "       55.530   % Impervious"
32 "       33.270   Total Area"
33 "      195.000   Flow length"
34 "        3.600   Overland Slope"
35 "       14.795   Pervious Area"
36 "      195.000   Pervious length"
37 "        3.600   Pervious slope"
38 "       18.475   Impervious Area"
39 "      195.000   Impervious length"
40 "        3.600   Impervious slope"
41 "        0.250   Pervious Manning 'n'"
42 "       81.000   Pervious SCS Curve No."
43 "        0.296   Pervious Runoff coefficient"
44 "        0.100   Pervious Ia/S coefficient"
45 "        5.958   Pervious Initial abstraction"
46 "        0.015   Impervious Manning 'n'"
47 "       98.000   Impervious SCS Curve No."
48 "        0.864   Impervious Runoff coefficient"
49 "        0.100   Impervious Ia/S coefficient"
50 "        0.518   Impervious Initial abstraction"
51 "                    4.829     0.000     0.000     0.000 c.m/sec"
52 "             Catchment 200          Pervious   Impervious Total Area "
53 "             Surface Area           14.795     18.475     33.270     hectare"
54 "             Time of concentration  43.993     4.970      13.367     minutes"
55 "             Time to Centroid       166.745    97.434     112.350    minutes"
56 "             Rainfall depth         38.145     38.145     38.145     mm"
57 "             Rainfall volume        0.5644     0.7047     1.2691     ha-m"
58 "             Rainfall losses        26.861     5.190      14.827     mm"
59 "             Runoff depth           11.284     32.955     23.318     mm"
60 "             Runoff volume          1669.47    6088.37    7757.83    c.m"
61 "             Runoff coefficient     0.296      0.864      0.611      "
62 "             Maximum flow           0.259      4.768      4.829      c.m/sec"
63 " 40          HYDROGRAPH Add Runoff "
64 "           4   Add Runoff "
```



```
65 "                    4.829     4.829     0.000     0.000"
66 " 54          POND DESIGN"
67 "        4.829   Current peak flow    c.m/sec"
68 "        0.421   Target outflow    c.m/sec"
69 "       7757.8   Hydrograph volume    c.m"
70 "          16.   Number of stages"
71 "      332.000   Minimum water level    metre"
72 "      333.500   Maximum water level    metre"
73 "      332.000   Starting water level    metre"
74 "            0   Keep Design Data: 1 = True; 0 = False"
75 "                  Level Discharge    Volume"
76 "               332.000     0.000     0.000"
77 "               332.100   0.00400   561.000"
78 "               332.200   0.00800  1134.000"
79 "               332.300   0.01059  1720.000"
80 "               332.400   0.01265  2318.000"
81 "               332.500   0.01443  2928.000"
82 "               332.600   0.01601  3551.000"
83 "               332.700   0.01744  4187.000"
84 "               332.800   0.07940  4840.000"
85 "               332.900    0.1915  5508.000"
86 "               333.000    0.3363  6186.000"
87 "               333.100    0.5075  6874.000"
88 "               333.200    0.7015  7572.000"
89 "               333.300    0.9157  8281.000"
90 "               333.400     1.149  9000.000"
91 "               333.500     1.399  9730.000"
92 "           1.   WEIRS"
93 "                  Crest      Weir     Crest      Left     Right"
94 "              elevation coefficie   breadth sideslope sideslope"
95 "                332.700     0.900     1.250     0.000     0.000"
96 "           1.   ORIFICES"
97 "                Orifice   Orifice   Orifice Number of"
98 "                 invert coefficie  diameter  orifices"
99 "                332.000     0.630    0.1000     1.000"
100 "             Peak outflow                  0.288    c.m/sec"
101 "             Maximum level               332.967    metre"
102 "             Maximum storage            5961.164    c.m"
103 "             Centroidal lag               31.778   hours"
104 "                  4.829     4.829     0.288     0.000 c.m/sec"
105 " 38          START/RE-START TOTALS 200"
106 "            3   Runoff Totals on EXIT"
107 "             Total Catchment area                     33.270    hectare"
108 "             Total Impervious area                    18.475    hectare"
109 "             Total % impervious                       55.530"
110 " 19          EXIT"
```

```
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 2 "               MIDUSS version                          Version 2.25  rev. 473"
 3 "               MIDUSS created                       Sunday, February 07, 2010"
 4 "          10   Units used:                                        ie METRIC"
 5 "               Job folder:              Q:\33886\Micro Drainage Analysis\SWM\"
 6 "                                                SWM Update - June 2017\MIDUSS"
 7 "               Output filename:                        33886-100-POST-10y.out"
 8 "               Licensee name:                                            MTE"
 9 "               Company                                  MTE Consultants Inc."
10 "               Date & Time last used:                6/21/2017 at 3:25:18 PM"
11 " 31          TIME PARAMETERS"
12 "        5.000   Time Step"
13 "      240.000   Max. Storm length"
14 "     1500.000   Max. Hydrograph"
15 " 32          STORM Chicago storm"
16 "           1   Chicago storm"
17 "      548.910   Coefficient A"
18 "        0.091   Constant B"
19 "        0.695   Exponent C"
20 "        0.400   Fraction R"
21 "      180.000   Duration"
22 "        1.000   Time step multiplier"
23 "             Maximum intensity           177.122    mm/hr"
24 "             Total depth                  44.571    mm"
25 "           6   010hyd   Hydrograph extension used in this file"
26 " 33          CATCHMENT 200"
27 "           1   Triangular SCS"
28 "           1   Equal length"
29 "           1   SCS method"
30 "         200   Site Post-Excavation"
31 "       55.530   % Impervious"
32 "       33.270   Total Area"
33 "      195.000   Flow length"
34 "        3.600   Overland Slope"
35 "       14.795   Pervious Area"
36 "      195.000   Pervious length"
37 "        3.600   Pervious slope"
38 "       18.475   Impervious Area"
39 "      195.000   Impervious length"
40 "        3.600   Impervious slope"
41 "        0.250   Pervious Manning 'n'"
42 "       81.000   Pervious SCS Curve No."
43 "        0.341   Pervious Runoff coefficient"
44 "        0.100   Pervious Ia/S coefficient"
45 "        5.958   Pervious Initial abstraction"
46 "        0.015   Impervious Manning 'n'"
47 "       98.000   Impervious SCS Curve No."
48 "        0.880   Impervious Runoff coefficient"
49 "        0.100   Impervious Ia/S coefficient"
50 "        0.518   Impervious Initial abstraction"
51 "                    5.738     0.000     0.000     0.000 c.m/sec"
52 "             Catchment 200          Pervious   Impervious Total Area "
53 "             Surface Area           14.795     18.475     33.270     hectare"
54 "             Time of concentration  38.540     4.646      12.664     minutes"
55 "             Time to Centroid       158.383    96.345     111.020    minutes"
56 "             Rainfall depth         44.571     44.571     44.571     mm"
57 "             Rainfall volume        0.6594     0.8234     1.4829     ha-m"
58 "             Rainfall losses        29.393     5.340      16.036     mm"
59 "             Runoff depth           15.178     39.232     28.535     mm"
60 "             Runoff volume          2245.68    7248.01    9493.68    c.m"
61 "             Runoff coefficient     0.341      0.880      0.640      "
62 "             Maximum flow           0.404      5.630      5.738      c.m/sec"
63 " 40          HYDROGRAPH Add Runoff "
64 "           4   Add Runoff "
```



```
65 "                    5.738     5.738     0.000     0.000"
66 " 54          POND DESIGN"
67 "        5.738   Current peak flow    c.m/sec"
68 "        0.653   Target outflow    c.m/sec"
69 "       9493.7   Hydrograph volume    c.m"
70 "          16.   Number of stages"
71 "      332.000   Minimum water level    metre"
72 "      333.500   Maximum water level    metre"
73 "      332.000   Starting water level    metre"
74 "            0   Keep Design Data: 1 = True; 0 = False"
75 "                  Level Discharge    Volume"
76 "               332.000     0.000     0.000"
77 "               332.100   0.00400   561.000"
78 "               332.200   0.00800  1134.000"
79 "               332.300   0.01059  1720.000"
80 "               332.400   0.01265  2318.000"
81 "               332.500   0.01443  2928.000"
82 "               332.600   0.01601  3551.000"
83 "               332.700   0.01744  4187.000"
84 "               332.800   0.07940  4840.000"
85 "               332.900    0.1915  5508.000"
86 "               333.000    0.3363  6186.000"
87 "               333.100    0.5075  6874.000"
88 "               333.200    0.7015  7572.000"
89 "               333.300    0.9157  8281.000"
90 "               333.400     1.149  9000.000"
91 "               333.500     1.399  9730.000"
92 "           1.   WEIRS"
93 "                  Crest      Weir     Crest      Left     Right"
94 "              elevation coefficie   breadth sideslope sideslope"
95 "                332.700     0.900     1.250     0.000     0.000"
96 "           1.   ORIFICES"
97 "                Orifice   Orifice   Orifice Number of"
98 "                 invert coefficie  diameter  orifices"
99 "               332.000     0.630    0.1000     1.000"
100 "             Peak outflow                  0.443    c.m/sec"
101 "             Maximum level               333.063    metre"
102 "             Maximum storage            6616.882    c.m"
103 "             Centroidal lag               26.703   hours"
104 "                  5.738     5.738     0.443     0.000 c.m/sec"
105 " 38          START/RE-START TOTALS 200"
106 "            3   Runoff Totals on EXIT"
107 "             Total Catchment area                     33.270    hectare"
108 "             Total Impervious area                    18.475    hectare"
109 "             Total % impervious                       55.530"
110 " 19          EXIT"
```

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 1 "               MIDUSS Output ------------------------------------------------>"
 2 "               MIDUSS version                          Version 2.25  rev. 473"
 3 "               MIDUSS created                       Sunday, February 07, 2010"
 4 "          10   Units used:                                        ie METRIC"
 5 "               Job folder:              Q:\33886\Micro Drainage Analysis\SWM\"
 6 "                                                SWM Update - June 2017\MIDUSS"
 7 "               Output filename:                        33886-100-POST-25y.out"
 8 "               Licensee name:                                            MTE"
 9 "               Company                                  MTE Consultants Inc."
10 "               Date & Time last used:                 6/21/2017 at 3:25:43 PM"
11 " 31          TIME PARAMETERS"
12 "        5.000   Time Step"
13 "      240.000   Max. Storm length"
14 "     1500.000   Max. Hydrograph"
15 " 32          STORM Chicago storm"
16 "           1   Chicago storm"
17 "      641.060   Coefficient A"
18 "        0.011   Constant B"
19 "        0.692   Exponent C"
20 "        0.400   Fraction R"
21 "      180.000   Duration"
22 "        1.000   Time step multiplier"
23 "             Maximum intensity           210.160    mm/hr"
24 "             Total depth                  52.888    mm"
25 "           6   025hyd   Hydrograph extension used in this file"
26 " 33          CATCHMENT 200"
27 "           1   Triangular SCS"
28 "           1   Equal length"
29 "           1   SCS method"
30 "         200   Site Post-Excavation"
31 "       55.530   % Impervious"
32 "       33.270   Total Area"
33 "      195.000   Flow length"
34 "        3.600   Overland Slope"
35 "       14.795   Pervious Area"
36 "      195.000   Pervious length"
37 "        3.600   Pervious slope"
38 "       18.475   Impervious Area"
39 "      195.000   Impervious length"
40 "        3.600   Impervious slope"
41 "        0.250   Pervious Manning 'n'"
42 "       81.000   Pervious SCS Curve No."
43 "        0.391   Pervious Runoff coefficient"
44 "        0.100   Pervious Ia/S coefficient"
45 "        5.958   Pervious Initial abstraction"
46 "        0.015   Impervious Manning 'n'"
47 "       98.000   Impervious SCS Curve No."
48 "        0.893   Impervious Runoff coefficient"
49 "        0.100   Impervious Ia/S coefficient"
50 "        0.518   Impervious Initial abstraction"
51 "                    6.759     0.000     0.000     0.000 c.m/sec"
52 "             Catchment 200          Pervious   Impervious Total Area "
53 "             Surface Area           14.795     18.475     33.270     hectare"
54 "             Time of concentration  33.630     4.317      11.924     minutes"
55 "             Time to Centroid       150.862    95.418     109.807    minutes"
56 "             Rainfall depth         52.888     52.888     52.888     mm"
57 "             Rainfall volume        0.7825     0.9771     1.7596     ha-m"
58 "             Rainfall losses        32.212     5.646      17.460     mm"
59 "             Runoff depth           20.675     47.242     35.428     mm"
60 "             Runoff volume          0.3059     0.8728     1.1787     ha-m"
61 "             Runoff coefficient     0.391      0.893      0.670      "
62 "             Maximum flow           0.616      6.563      6.759      c.m/sec"
63 " 40          HYDROGRAPH Add Runoff "
64 "           4   Add Runoff "
```



```
65 "                    6.759     6.759     0.000     0.000"
66 " 54          POND DESIGN"
67 "        6.759   Current peak flow    c.m/sec"
68 "        0.982   Target outflow    c.m/sec"
69 "      11786.8   Hydrograph volume    c.m"
70 "          16.   Number of stages"
71 "      332.000   Minimum water level    metre"
72 "      333.500   Maximum water level    metre"
73 "      332.000   Starting water level    metre"
74 "            0   Keep Design Data: 1 = True; 0 = False"
75 "                  Level Discharge    Volume"
76 "                332.000     0.000     0.000"
77 "                332.100   0.00400   561.000"
78 "                332.200   0.00800  1134.000"
79 "                332.300   0.01059  1720.000"
80 "                332.400   0.01265  2318.000"
81 "                332.500   0.01443  2928.000"
82 "                332.600   0.01601  3551.000"
83 "                332.700   0.01744  4187.000"
84 "                332.800   0.07940  4840.000"
85 "                332.900    0.1915  5508.000"
86 "                333.000    0.3363  6186.000"
87 "                333.100    0.5075  6874.000"
88 "                333.200    0.7015  7572.000"
89 "                333.300    0.9157  8281.000"
90 "                333.400     1.149  9000.000"
91 "                333.500     1.399  9730.000"
92 "           1.   WEIRS"
93 "                  Crest      Weir     Crest      Left     Right"
94 "              elevation coefficie   breadth sideslope sideslope"
95 "                332.700     0.900     1.250     0.000     0.000"
96 "           1.   ORIFICES"
97 "                Orifice   Orifice   Orifice Number of"
98 "                 invert coefficie  diameter  orifices"
99 "                332.000     0.630    0.1000     1.000"
100 "             Peak outflow                  0.680    c.m/sec"
101 "             Maximum level               333.189    metre"
102 "             Maximum storage            7494.173    c.m"
103 "             Centroidal lag               22.179   hours"
104 "                  6.759     6.759     0.680     0.000 c.m/sec"
105 " 38          START/RE-START TOTALS 200"
106 "            3   Runoff Totals on EXIT"
107 "             Total Catchment area                     33.270    hectare"
108 "             Total Impervious area                    18.475    hectare"
109 "             Total % impervious                       55.530"
110 " 19          EXIT"
```

```
 1 "               MIDUSS Output ------------------------------------------------>"
 2 "               MIDUSS version                          Version 2.25  rev. 473"
 3 "               MIDUSS created                       Sunday, February 07, 2010"
 4 "           10  Units used:                                        ie METRIC"
 5 "               Job folder:              Q:\33886\Micro Drainage Analysis\SWM\"
 6 "                                               SWM Update - June 2017\MIDUSS"
 7 "               Output filename:                        33886-100-POST-50y.out"
 8 "               Licensee name:                                          MTE"
 9 "               Company                                  MTE Consultants Inc."
10 "               Date & Time last used:                6/21/2017 at 3:26:09 PM"
11 " 31          TIME PARAMETERS"
12 "        5.000   Time Step"
13 "      240.000   Max. Storm length"
14 "     1500.000   Max. Hydrograph"
15 " 32          STORM Chicago storm"
16 "           1   Chicago storm"
17 "      721.060   Coefficient A"
18 "        0.031   Constant B"
19 "        0.695   Exponent C"
20 "        0.400   Fraction R"
21 "      180.000   Duration"
22 "        1.000   Time step multiplier"
23 "             Maximum intensity           234.597    mm/hr"
24 "             Total depth                  58.563    mm"
25 "           6   050hyd   Hydrograph extension used in this file"
26 " 33          CATCHMENT 200"
27 "           1   Triangular SCS"
28 "           1   Equal length"
29 "           1   SCS method"
30 "         200   Site Post-Excavation"
31 "       55.530   % Impervious"
32 "       33.270   Total Area"
33 "      195.000   Flow length"
34 "        3.600   Overland Slope"
35 "       14.795   Pervious Area"
36 "      195.000   Pervious length"
37 "        3.600   Pervious slope"
38 "       18.475   Impervious Area"
39 "      195.000   Impervious length"
40 "        3.600   Impervious slope"
41 "        0.250   Pervious Manning 'n'"
42 "       81.000   Pervious SCS Curve No."
43 "        0.421   Pervious Runoff coefficient"
44 "        0.100   Pervious Ia/S coefficient"
45 "        5.958   Pervious Initial abstraction"
46 "        0.015   Impervious Manning 'n'"
47 "       98.000   Impervious SCS Curve No."
48 "        0.898   Impervious Runoff coefficient"
49 "        0.100   Impervious Ia/S coefficient"
50 "        0.518   Impervious Initial abstraction"
51 "                    7.603     0.000     0.000     0.000 c.m/sec"
52 "             Catchment 200          Pervious   Impervious Total Area "
53 "             Surface Area           14.795     18.475     33.270     hectare"
54 "             Time of concentration  31.038     4.121      11.465     minutes"
55 "             Time to Centroid       146.549    94.772     108.901    minutes"
56 "             Rainfall depth         58.563     58.563     58.563     mm"
57 "             Rainfall volume        0.8665     1.0819     1.9484     ha-m"
58 "             Rainfall losses        33.906     5.945      18.379     mm"
59 "             Runoff depth           24.657     52.619     40.184     mm"
60 "             Runoff volume          0.3648     0.9721     1.3369     ha-m"
61 "             Runoff coefficient     0.421      0.898      0.686      "
62 "             Maximum flow           0.819      7.327      7.603      c.m/sec"
63 " 40          HYDROGRAPH Add Runoff "
64 "           4   Add Runoff "
```



```
65 "                    7.603     7.603     0.000     0.000"
66 " 54          POND DESIGN"
67 "        7.603   Current peak flow    c.m/sec"
68 "        1.314   Target outflow    c.m/sec"
69 "      13369.2   Hydrograph volume    c.m"
70 "          16.   Number of stages"
71 "      332.000   Minimum water level    metre"
72 "      333.500   Maximum water level    metre"
73 "      332.000   Starting water level    metre"
74 "            0   Keep Design Data: 1 = True; 0 = False"
75 "                  Level Discharge    Volume"
76 "                332.000     0.000     0.000"
77 "                332.100   0.00400   561.000"
78 "                332.200   0.00800  1134.000"
79 "                332.300   0.01059  1720.000"
80 "                332.400   0.01265  2318.000"
81 "                332.500   0.01443  2928.000"
82 "                332.600   0.01601  3551.000"
83 "                332.700   0.01744  4187.000"
84 "                332.800   0.07940  4840.000"
85 "                332.900    0.1915  5508.000"
86 "                333.000    0.3363  6186.000"
87 "                333.100    0.5075  6874.000"
88 "                333.200    0.7015  7572.000"
89 "                333.300    0.9157  8281.000"
90 "                333.400     1.149  9000.000"
91 "                333.500     1.399  9730.000"
92 "           1.   WEIRS"
93 "                  Crest      Weir     Crest      Left     Right"
94 "              elevation coefficie   breadth sideslope sideslope"
95 "                332.700     0.900     1.250     0.000     0.000"
96 "           1.   ORIFICES"
97 "                Orifice   Orifice   Orifice Number of"
98 "                 invert coefficie  diameter  orifices"
99 "                332.000     0.630    0.1000     1.000"
100 "             Peak outflow                  0.873    c.m/sec"
101 "             Maximum level               333.280    metre"
102 "             Maximum storage            8138.307    c.m"
103 "             Centroidal lag               19.953   hours"
104 "                  7.603     7.603     0.873     0.000 c.m/sec"
105 " 38          START/RE-START TOTALS 200"
106 "            3   Runoff Totals on EXIT"
107 "             Total Catchment area                     33.270    hectare"
108 "             Total Impervious area                    18.475    hectare"
109 "             Total % impervious                       55.530"
110 " 19          EXIT"
```

```
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 8 "               Licensee name:                                          MTE"
 9 "               Company                                  MTE Consultants Inc."
10 "               Date & Time last used:                6/21/2017 at 3:27:03 PM"
11 " 31          TIME PARAMETERS"
12 "        5.000   Time Step"
13 "      240.000   Max. Storm length"
14 "     1500.000   Max. Hydrograph"
15 " 32          STORM Chicago storm"
16 "            1   Chicago storm"
17 "      797.520   Coefficient A"
18 "        0.036   Constant B"
19 "        0.695   Exponent C"
20 "        0.400   Fraction R"
21 "      180.000   Duration"
22 "        1.000   Time step multiplier"
23 "             Maximum intensity           259.294    mm/hr"
24 "             Total depth                  64.772    mm"
25 "            6   100hyd   Hydrograph extension used in this file"
26 " 33          CATCHMENT 200"
27 "            1   Triangular SCS"
28 "            1   Equal length"
29 "            1   SCS method"
30 "          200   Site Post-Excavation"
31 "       55.530   % Impervious"
32 "       33.270   Total Area"
33 "      195.000   Flow length"
34 "        3.600   Overland Slope"
35 "       14.795   Pervious Area"
36 "      195.000   Pervious length"
37 "        3.600   Pervious slope"
38 "       18.475   Impervious Area"
39 "      195.000   Impervious length"
40 "        3.600   Impervious slope"
41 "        0.250   Pervious Manning 'n'"
42 "       81.000   Pervious SCS Curve No."
43 "        0.451   Pervious Runoff coefficient"
44 "        0.100   Pervious Ia/S coefficient"
45 "        5.958   Pervious Initial abstraction"
46 "        0.015   Impervious Manning 'n'"
47 "       98.000   Impervious SCS Curve No."
48 "        0.902   Impervious Runoff coefficient"
49 "        0.100   Impervious Ia/S coefficient"
50 "        0.518   Impervious Initial abstraction"
51 "                     8.477     0.000     0.000     0.000 c.m/sec"
52 "             Catchment 200          Pervious   Impervious Total Area "
53 "             Surface Area           14.795     18.475     33.270     hectare"
54 "             Time of concentration  28.855     3.950      11.067     minutes"
55 "             Time to Centroid       142.929    94.228     108.146    minutes"
56 "             Rainfall depth         64.772     64.772     64.772     mm"
57 "             Rainfall volume        0.9583     1.1967     2.1550     ha-m"
58 "             Rainfall losses        35.587     6.359      19.357     mm"
59 "             Runoff depth           29.185     58.413     45.415     mm"
60 "             Runoff volume          0.4318     1.0792     1.5110     ha-m"
61 "             Runoff coefficient     0.451      0.902      0.701      "
62 "             Maximum flow           1.020      8.097      8.477      c.m/sec"
63 " 40          HYDROGRAPH Add Runoff "
64 "            4   Add Runoff "
```



```
65 "                     8.477     8.477     0.000     0.000"
66 " 54          POND DESIGN"
67 "        8.477   Current peak flow    c.m/sec"
68 "        1.639   Target outflow    c.m/sec"
69 "      15109.7   Hydrograph volume    c.m"
70 "          16.   Number of stages"
71 "      332.000   Minimum water level    metre"
72 "      333.500   Maximum water level    metre"
73 "      332.000   Starting water level    metre"
74 "            0   Keep Design Data: 1 = True; 0 = False"
75 "                  Level Discharge    Volume"
76 "                332.000     0.000     0.000"
77 "                332.100   0.00400   561.000"
78 "                332.200   0.00800  1134.000"
79 "                332.300   0.01059  1720.000"
80 "                332.400   0.01265  2318.000"
81 "                332.500   0.01443  2928.000"
82 "                332.600   0.01601  3551.000"
83 "                332.700   0.01744  4187.000"
84 "                332.800   0.07940  4840.000"
85 "                332.900    0.1915  5508.000"
86 "                333.000    0.3363  6186.000"
87 "                333.100    0.5075  6874.000"
88 "                333.200    0.7015  7572.000"
89 "                333.300    0.9157  8281.000"
90 "                333.400     1.149  9000.000"
91 "                333.500     1.399  9730.000"
92 "           1.   WEIRS"
93 "                  Crest      Weir     Crest      Left     Right"
94 "              elevation coefficie   breadth sideslope sideslope"
95 "                332.700     0.900     1.250     0.000     0.000"
96 "           1.   ORIFICES"
97 "                Orifice   Orifice   Orifice Number of"
98 "                 invert coefficie  diameter  orifices"
99 "                332.000     0.630    0.1000     1.000"
100 "             Peak outflow                  1.098    c.m/sec"
101 "             Maximum level               333.378    metre"
102 "             Maximum storage            8844.590    c.m"
103 "             Centroidal lag               17.997   hours"
104 "                  8.477     8.477     1.098     0.000 c.m/sec"
105 " 38          START/RE-START TOTALS 200"
106 "            3   Runoff Totals on EXIT"
107 "             Total Catchment area                     33.270    hectare"
108 "             Total Impervious area                    18.475    hectare"
109 "             Total % impervious                       55.530"
110 " 19          EXIT"
```

FREYMOND QUARRY
STORMWATER MANAGEMENT
Bancroft, Ontario

Project Number: 33886-100
Date: June 20, 2017
Designer: KMR/CJC
File: Q:\33886\Micro Drainage Analysis\SWM\SWM Update - June 2017\33886-100 SWM Design-June 2017.xlsx

QUANTITY CONTROL MODELING SUMMARY (Permanent Pool = 332.00m)

Storm Event	Pre-Excavation Peak Flow (m^3/s)	Pre-Excavation Runoff Volume (m^3)	Post-Excavation Pond Inflow (m^3/s)	Post-Excavation Runoff Volume (m^3)	Post-Excavation Pond Outflow (m^3/s)	Required Storage Volume (m^3)	Peak Ponding Elevation (m)
25mm	0.098	1333	2.709	4392	0.017	4062	332.68
2 Year	0.169	1765	3.414	5220	0.064	4682	332.78
5 Year	0.421	3260	4.829	7758	0.288	5961	332.97
10 Year	0.653	4385	5.738	9494	0.443	6617	333.06
25 Year	0.982	5972	6.759	11787	0.680	7494	333.19
50 Year	1.314	7124	7.603	13370	0.873	8138	333.28
100 Year	1.639	8438	8.477	15110	1.098	8845	333.38

IDF PARAMETERS - MTO Curve Lookup Application; Bancroft

Frequency	a	b	c	t_{TOTAL} (min.)
25mm	282.1	0.116	0.6954	240
2 Year	348.96	0.116	0.6954	180
5 Year	464.78	0.019	0.6928	180
10 Year	548.91	0.091	0.6948	180
25 Year	641.06	0.011	0.6923	180
50 Year	721.06	0.031	0.6946	180
100 Year	797.52	0.036	0.6954	180

$Intensity = a / (t + b)^{c}$

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FALLING HEAD DRAWDOWN CALCULATION
MOEE SWM Planning and Design Manual, 2003

$$t = \frac{0.66C_2h^{1.5} + 2C_3h^{0.5}}{2.75A_O}$$ Equation 4.11

where

t =	255431	*s*	
	71.0	*hr*	drawdown time
A_p =	5947.02	m^2	surface area of the pond
C =	0.63		discharge coefficient
d =	100	*mm*	diameter of the orifice
A_O =	0.00785	m^2	cross-sectional area of the orifice
g =	9.81	m/s^2	gravitational acceleration constant
h_1 =	332.230	*m*	starting water elevation above the orifice
h_2 =	332.000	*m*	ending water elevation above the orifice
h =	0.23	*m*	maximum water elevation above the orifice
C_2 =	1266.94		slope coefficient from the area-depth linear regression
C_3 =	5655.62		intercept from the area-depth linear regression

	ELEVATION *m*	STAGE *m*	AREA m^2	COMMENTS
1	332.000	0	5656.8	
2	332.100	0.1	5782.1	
3	332.200	0.2	5908.1	
4	332.300	0.3	6034.7	
5	332.400	0.4	6162.2	
6	332.500	0.5	6290.3	

DRAWDOWN TIME: 255431 *s*
71.0 *hr*

Regression Output:

m_1 =	1266.94	slope coefficient from the area-depth linear regression
b =	5655.62	intercept from the area-depth linear regression
se_1 =	2.59	standard error for coefficient m_1
se_b =	0.79	standard error for constant b
R^2 =	1.0000	coefficient of determination
se_y =	1.08	standard error of the *y* estimate
F =	2.39E+05	F statistic
df =	4	degrees of freedom
ss_{reg} =	280899	regression sum of squares
ss_{resid} =	5	residual sum of squares

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SETTLING CALCULATIONS
MOE SWM Planning and Design Manual, 2003

Design Flows

Peak flow into facility during the 1:100-year return period event	8.477	m^3/s
Peak flow into facility during the 25 mm - 4 hour design storm event	2.709	m^3/s
Peak flow from facility outlet for the 25 mm - 4 hour design storm event	0.017	m^3/s

Facility Characteristics

b =	5.0	*m*	bottom width
y =	3	*m*	25mm storm storage depth
z =	4	:1	side slope
w =	17.0	*m*	average width
R =	1.71	*m*	hydraulic radius
A =	51.0	m^2	cross-sectional area

1. Length Calculation Based on Settling Velocity

L = facility flow length *(m)*
r = length-to-width ratio
Q_p = peak flow rate through facility *(m^3/s)*
v_s = settling velocity *(m/s)*

$$L = \sqrt{\frac{rQ_p}{v_s}}$$ Equation 4.5: Forebay Settling Length

a) Required Settling Length (assuming Q_p = pond discharge & v_s = 0.00002540 m/s)

Q_p =	0.017	m^3/s	peak flow rate through facility
v_s =	0.00002540	*m/s*	settling velocity
r =	2.31		length-to-width ratio
L =	39.3	*m*	required settling length
L =	*39.3*	*m*	*trial length*

b) Required Settling Length (assuming Q_p = pond discharge & v_s = 0.00001300 m/s)

Q_p =	0.017	m^3/s	peak flow rate through facility
v_s =	0.00001300	*m/s*	settling velocity
r =	4.52		length-to-width ratio
L =	76.9	*m*	required settling length
L =	*76.9*	*m*	*trial length*

Table 1: Average settling velocities

	Mass Removed	Particle Size Range	Average Settling Velocity
	%	*µm*	*m/s*
	80 - 100	x ≤ 20	0.00000254
Enhanced:	70 - 80	20 < x ≤ 40	0.00001300
Normal:	60 - 70	40 < x ≤ 60	0.00002540
Basic:	40 - 60	60 < x ≤ 130	0.00012700
Medium Sand:	20 - 40	130 < x ≤ 400	0.00059267
Gross Grit:	0 - 20	400 < x ≤ 4000	0.00550333

2. Length Calculation Based on Flow Dispersion Length

Q =	8.48	m^3/s	peak inlet flow rate
d =	3	*m*	depth of permanent pool in facility
V_f =	0.50	*m/s*	desired velocity in facility (typical value ≤ 0.50 *m/s*)
L =	45.2	m	required length of dispersion

$$L_D = \frac{8Q}{dV_f}$$ Equation 4.6: Dispersion Length

3. Required Facility Length

L =	**76.9**	***m***	**design length**
r =	4.52		design length-to-width ratio (typical minimum of 2.0)

4. Scour Velocity

v_s =	0.15	*m/s*	scour velocity (typical value = 0.15 *m/s*)
v =	**0.166**	***m/s***	**actual velocity**

ERROR! ERROR! The actual velocity through the facility exceeds the scour veloci

5. Estimated Cleanout Frequency

Facility

Spare permanent pool volume beyond requirement	2648	m^3
Estimated TSS removal efficiency	80%	
Impervious level	56%	
Estimated annual sediment loading	1.9	m^3/ha
Contributing area	33.27	*ha*
Annual sediment volume	51	m^3/yr
Frequency for 100% spare volume reduction	**52.4**	***years***

Table 2: Annual sediment loading

Impervious Level	Annual Loading
%	m^3/ha
35%	0.6
55%	1.9
70%	2.8
85%	3.8

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Step 1: Choose Level of Water Quality Control

Enhanced 80% long-term S.S. removal

Step 2: Choose Type of Facility

Wet Pond

Step 3: Define Catchment area and Imperviousness

Catchment Area (ha)	Imperviousness (%)
33.27	55.53

Interpolated Storage Volume Requirement (m^3/ha)

191.24

Permanent Pool Required (m^3)

5031.92

Extended Detention Volume Required (m^3)

1330.80

Table 3.2 Water Quality Storage Requirements based on Receiving Waters (from MOE Stormwater Management Planning and Design Manual, March 2003)

Protection Level	SWMP Type	Storage Volume (m^3/ha) for Impervious Level			
		35	55	70	85
Enhanced 80% long-term S.S. removal	*Wetlands*	80	105	120	140
	Hybrid Wet Pond/Wetland	110	150	175	195
	Wet Pond	140	190	225	250
Normal 70% long-term S.S. Removal	*Wetlands*	60	70	80	90
	Hybrid Wet Pond/Wetland	75	90	105	120
	Wet Pond	90	110	130	150
Basic 60% long-term S.S. Removal	*Wetlands*	60	60	60	60
	Hybrid Wet Pond/Wetland	60	70	75	80
	Wet Pond	60	75	85	95
	Dry Pond (Continuous Flow)	90	150	200	240

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STAGE-STORAGE RELATIONSHIP - WET POND

Stage	Active Depth	Main Pond			Total Pond Volume	Active Storage Volume	Total Outflow*	Volume Summary	Ponding Elevation	Comments	Stage
		Area	Volume	Cumulative Volume							
m	*m*	m^2	m^3	m^3	m^3	m^3	m^3/s	m^3	*m*		*m*
329.00		758	0	0	0		*from				329.00
329.10		859	81	81	81		MIDUSS				329.10
329.20		963	91	172	172						329.20
329.30		1070	102	274	274		100mm				329.30
329.40		1178	112	386	386		orifice				329.40
329.50		1290	123	509	509		@ 332.00m				329.50
329.60		1404	135	644	644		+				329.60
329.70		1520	146	790	790		1.25m				329.70
329.80		1639	158	948	948		weir				329.80
329.90		1760	170	1118	1118		@ 332.70m				329.90
330.00		1883	182	1300	1300						330.00
330.10		2006	194	1495	1495						330.10
330.20		2132	207	1702	1702						330.20
330.30		2258	219	1921	1921						330.30
330.40		2386	232	2153	2153						330.40
330.50		2515	245	2398	2398						330.50
330.60		2645	258	2656	2656						330.60
330.70		2777	271	2928	2928						330.70
330.80		2908	284	3212	3212						330.80
330.90		3040	297	3509	3509						330.90
331.00		3174	311	3820	3820						331.00
331.10		3308	324	4144	4144						331.10
331.20		3443	338	4482	4482						331.20
331.30		3580	351	4833	4833						331.30
331.40		3717	365	5198	5198						331.40
331.50		3856	379	5576	5576						331.50
331.60		3995	393	5969	5969						331.60
331.70		4135	407	6375	6375						331.70
331.80		4277	421	6796	6796						331.80
331.90		4419	435	7231	7231						331.90
332.00		4563	449	7680	7680			7680		Permanent Pool	332.00
332.00	0.00	5549	296	7975	7975	0	0.000				332.00
332.10	0.10	5671	561	8536	8536	561	0.004				332.10
332.20	0.20	5794	573	9110	9110	1134	0.008	1331	332.24	MOE Extended Detention	332.20
332.30	0.30	5918	586	9695	9695	1720	0.011				332.30
332.40	0.40	6042	598	10293	10293	2318	0.013				332.40
332.50	0.50	6167	610	10904	10904	2928	0.014				332.50
332.60	0.60	6293	623	11527	11527	3551	0.016	4062	332.69	25mm Event	332.60
332.70	0.70	6421	636	12162	12162	4187	0.017	4682	332.78	1:2 Year Event	332.70
332.80	0.80	6631	653	12815	12815	4840	0.079				332.80
332.90	0.90	6730	668	13483	13483	5508	0.192	5961	332.97	1:5 Year Event	332.90
333.00	1.00	6831	678	14161	14161	6186	0.336	6617	333.07	1:10 Year Event	333.00
333.10	1.10	6933	688	14849	14849	6874	0.508	7494	333.20	1:25 Year Event	333.10
333.20	1.20	7036	698	15548	15548	7572	0.702	8138	333.29	1:50 Year Event	333.20
333.30	1.30	7139	709	16256	16256	8281	0.916	8845	333.38	1:100 Year Event	333.30
333.40	1.40	7244	719	16976	16976	9000	1.149				333.40
333.50	1.50	7350	730	17705	17705	9730	1.399				333.50