EXAMPLE #1

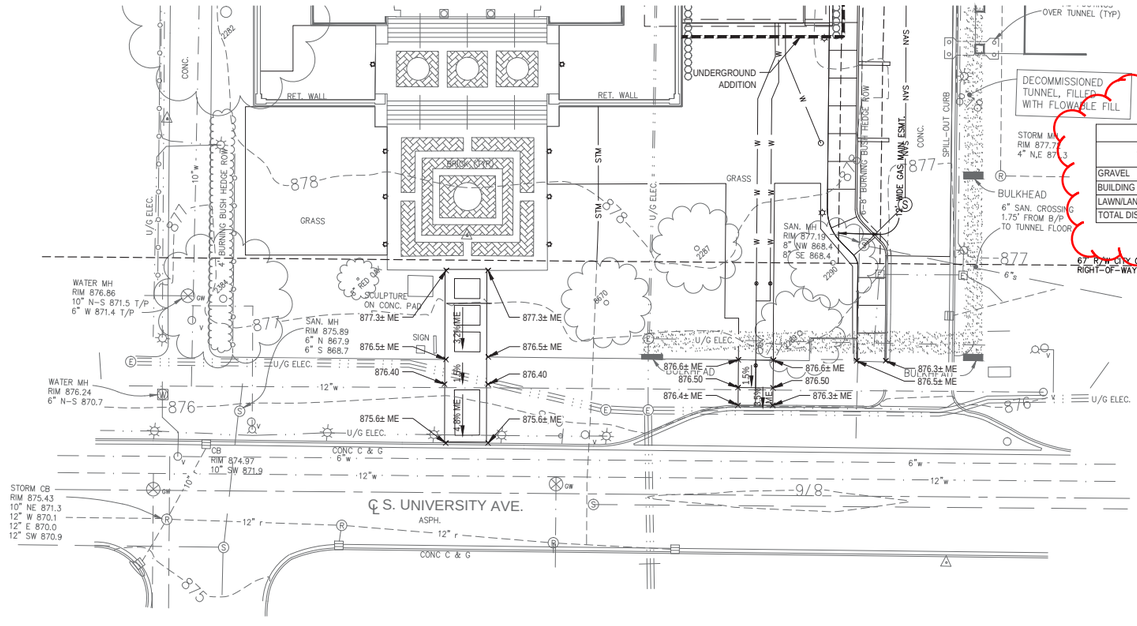
For projects less than one acre and no new connections to the City/County storm sewers

Storm Water Notes:
1. No new connections to city storm sewer systems are proposed.
2. Proposed earth disturbance is _____SF (_____ acres).
3. U-M NPDES permit post-construction storm water management requirements are not applicable since the proposed earth disturbance is less than one acre.

Show chart of with change in impervious -see attached example chart. Increase in impervious must be reviewed/approved by U-M Campus Planning and project team may be directed to design additional storm water management BMPs.

Provide a list of elective storm water BMP's to be installed and quantify benefits, if feasible.

Include the language: "Construction and operation of the storm water (infiltration/detention pond) or (BMP's on the plans) is/are in compliance with the requirements of State and Federal water pollution control laws."



AREA COMPARISON (TOTAL SITE)		
TYPE	EXISTING AREA (SF)	PROPOSED AREA (SF)
GRAVEL	865	0
BUILDING ROOF/PAVING	18,655	15,285
LAWN/LANDSCAPE	21,193	25,428
TOTAL DISTURBED AREA	40,713	40,713

GRADING & DRAINAGE LEGEND

- STM — STORM SEWER PIPING
- W — WATER MAIN PIPING; SEE CU1.1
- 800 — MAJOR CONTOUR LINE
- 800 — MINOR CONTOUR LINE
- 800 — EXISTING CONTOUR LINE
- 800 — SPOT ELEVATION
- 1% — GRADE

GRADING & DRAINAGE ABBREVIATIONS

G = GUTTER
ME = MEET EXISTING
T/C = TOP OF CURB

Replace chart with format matching example chart below

Area Comparision (for earth disturbance)			
Type	CN	Existing Area (sf)	Proposed Area (sf)
Gravel	85	3500	0
Bldg Roof/Pavement	98	3000	3500
Lawn/Landscaping	61	6500	8000
Pervious Pavement	79.5	0	1500
Total Disturbed area		13000	13000
Total Impervious		6500	3500
Composite CN		76	73

SMITHGROUP JJR
500 GRISWOLD
SUITE 1700
DETROIT, MI 48226
313.983.3600
www.smithgroupjjr.com

3 WORKING DAYS
BEFORE YOU DIG CALL MISS DIG
800-482-7171
(TOLL FREE)

PROJECT NORTH

BENCH MARK | SURVEY BOOK

REV. NO.	DESCRIPTION	DATE	DR.BY	CH.BY
1	CD FINAL REVIEW/CITY PLAN REVIEW	10/3/13	JBW	JBW
0	CITY PPR SUBMITTAL	8/23/13	JBW	JBW

PROJECT MANAGEMENT - PUBLIC SERVICES - CITY OF ANN ARBOR

UNIVERSITY OF MICHIGAN
WILLIAM L. CLEMENTS LIBRARY INFRASTRUCTURE IMPROVEMENTS AND ADDITION
UM PROJECT NUMBER: P00001692
RIGHT OF WAY GRADING PLAN

APPROVED BY _____

SCALE HORIZ. 1"=20' VERT. 1"=2' | INCH 0 1
DRAWING NO. CG1.1
SHEET NO. ____ OF ____

FILE: \\dt-file1\Projects\22239.000\CAD\c\sht\22239-GRAD.dwg USER: jwywcot DATE: Oct. 03, 2013 TIME: 12:30 pm

EXAMPLE #2

Greater than an acre, new connection to the City System

UNIVERSITY OF MICHIGAN

ATHLETIC DEPARTMENT OPERATIONS CENTER

PRELIMINARY SITE PLAN REVIEW

UM AEC Proj No #: P00008399;

THE UNIVERSITY OF MICHIGAN
ATHLETICS DEPARTMENT
ANN ARBOR, MI 48105

For City projects only - Title Sheet Listing type of City Review

THE UNIVERSITY OF MICHIGAN
Architecture, Engineering and Construction
University Architect's Office
326 E. Hoover Ave.
Mail Stop E
ANN ARBOR, MICHIGAN 48109-1002

NIAGARA MURANO
ARCHITECTURE
2215 COLE STREET
BIRMINGHAM, MICHIGAN 48009
TELEPHONE: 248.646.5765
FACSIMILE: 248.646.5813

Architect's Project No. - 13144.0

SPALDING DEDECKER ASSOCIATES, INC.

SPALDING DEDECKER ASSOCIATES
905 SOUTH BOULEVARD EAST
ROCHESTER HILLS, MI 48307
P (248) 844 - 5400

C I V I L

T-1C	COVER SHEET
C001C	TOPO SURVEY
C002C	DEMOLITION PLAN
C101C	SITE PLAN
C102C	UTILITY PLAN - RIGHT-OF-WAY
C103C	PAVING PLAN - RIGHT-OF-WAY
C104C	STORMWATER MANAGEMENT SUMMARY SHEET
C104AC	STORMWATER MANAGEMENT PLAN
C104BC	STORMWATER MANAGEMENT DETAILS
C105C	FIRE SAFETY SITE PLAN



VICINITY PLAN

SCALE: NTS

UNIVERSITY of MICHIGAN
UM Athletic Department Operations Center
ANN ARBOR, MICHIGAN 48105

W O R K S C O P E

NEW OPERATIONS BUILDING
INCLUDES ADMINISTRATION OFFICES, LAUNDRY FACILITIES, ATHLETICS GENERAL STORAGE, LOADING DOCK AND A MAINTENANCE SHOP FOR MINOR REPAIRS. THESE REPAIR FUNCTIONS MILLWORK, WELDING, PAINTING AND SMALL EQUIPMENT. THE BUILDING IS APPROXIMATELY 18,500 SF OF SPACE. THE BUILDING IS STEEL FRAMED W/ INSULATED METAL PANEL AND INSULATED MASONRY VENEER WALLS. INTERIOR FINISHES INCLUDE CMU, GYPSUM BOARD, CEILINGS ARE EXPOSED METAL DECK PAINTED.

issue:	date:
City Site Plan Review	April 28, 2014
Prelim. City Site Plan Review	March 19, 2014
Owner Review	Feb 19, 2014
DD Review	December 20, 2013
SD Review	November 27, 2013
Owner Review	October 28th 2013
Owner Review	October 28th 2013
Owner Review	October 21st 2013
Owner Review	October 9th 2013

University of Michigan

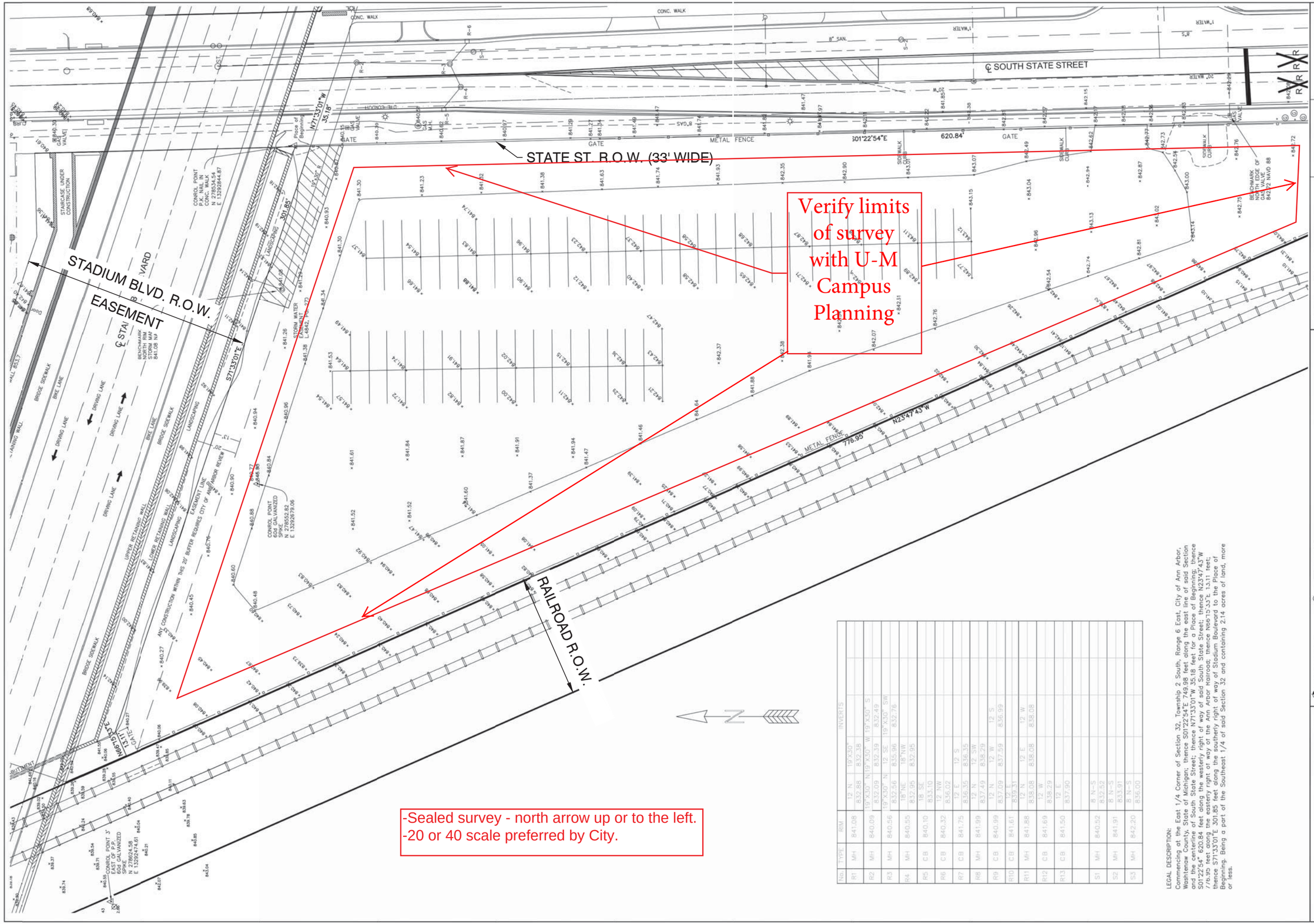
submitted to: HFES	NO	BFS:	NO
AEC constr mgmt no.			P00008399
building no.			-
designed			David B
drawn			SB, RHS & GG
coordination checked			John K.
checked	R Sherman	approved	John K.
um design manager			
location			UM Athletic Ops Center
keywords			TITLE

project:
UM Athletic Department Operations Center

sheet title:
PRELIMINARY CITY SITE PLAN REVIEW

project number: UM AEC : P00008399

sheet number: T-1C



No.	TYPE	RIM	INVERTS		
R1	MH	841.08	12" N	19"X30"	
			8.52.86	8.52.36	
R2	MH	840.09	19"X30" N	19"X30" W	19"X30" S
			8.52.09	8.52.39	8.52.49
R3	MH	840.46	19"X30" N	12" SE	19"X30" SW
			8.52.56	8.55.96	8.52.76
R4	MH	840.55	18"NE	18"NW	
			8.52.95	8.52.95	
R5	CB	840.10	18" SE		
			8.53.10		
R6	CB	840.32	12" NW		
			8.56.02		
R7	CB	841.75	12" E	12" S	
			8.56.35	8.56.35	
R8	MH	841.99	12" N	12" SW	
			8.57.49	8.58.29	
R9	CB	840.99	12" N	12" W	12" S
			8.57.09	8.57.59	8.56.99
R10	CB	841.61	12" E		
			8.59.31		
R11	MH	841.88	12" N	12" E	12" W
			8.58.08	8.58.08	8.58.08
R12	CB	841.69	12" W		
			8.58.29		
R13	CB	841.50	12" E		
			8.57.90		
				8" N-S	
S1	MH	840.52	8.52.52	8" N-S	
S2	MH	841.91	8.53.91	8" N-S	
S3	MH	842.20	8.56.00	8" N-S	

-Sealed survey - north arrow up or to the left.
-20 or 40 scale preferred by City.

LEGAL DESCRIPTION:
Commencing at the East 1/4 Corner of Section 32, Township 2 South, Range 6 East, City of Ann Arbor, Washtenaw County, Michigan; thence S01°22'54"E 740.98 feet along the East line of said Section and the centerline of South State Street; thence N71°33'01"W 35.18 feet to a Place of Beginning; thence S01°22'54" 620.84 feet along the westerly right of way of said South State Street; thence N23°47'43"W 776.95 feet along the easterly right of way of the Ann Arbor Railroad; thence N66°13'33"E 13.11 feet; thence S71°33'01"E 301.85 feet along the southerly right of way of Stadium Boulevard to the Place of Beginning. Being a part of the Southeast 1/4 of said Section 32 and containing 2.14 acres of land, more or less.

THE UNDERGROUND UTILITIES SHOWN HAVE BEEN LOCATED FROM FIELD OBSERVED INFORMATION AND EXISTING DRAWINGS. THE SURVEYOR MAKES NO GUARANTEES THAT THE UNDERGROUND UTILITIES SHOWN COMPRISE ALL SUCH UTILITIES IN THE AREA, EITHER IN SERVICE OR ABANDONED. THE SURVEYOR FURTHER DOES NOT WARRANT THAT THE UNDERGROUND UTILITIES SHOWN ARE IN THE EXACT LOCATION INDICATED ALTHOUGH HE DOES CERTIFY THAT THEY ARE LOCATED AS ACCURATELY AS POSSIBLE FROM INFORMATION AVAILABLE. THE SURVEYOR HAS NOT PHYSICALLY LOCATED THE UNDERGROUND UTILITIES OTHER THAN THE STRUCTURE INVENTORY SHOWN HEREON.

Know what's below. Call before you dig.

SECTION CORNER
FOUND IRON PIPE
FOUND IRON ROD
SET IRON PIPE
SET MAG NAIL
FOUND MAG NAIL
CONTROL POINT
(M) MEASURED DIMENSION
(R) RECORDED DIMENSION
SURFACE FLOW

WATER MANHOLE
FIRE HYDRANT
GATE VALVE
BEEHIVE CATCH BASIN
CURB CATCH BASIN
STORM MANHOLE
CULVERT / END SECTION
SANITARY MANHOLE
LIGHT POLE
UTILITY POLE
TELEPHONE RISER
GAS MAIN RISER

ELECTRIC LINE
GAS MAIN
WATER MAIN
STORM LINE
SANITARY LINE
CABLE TV LINE
PHONE LINE
CHAIN LINK FENCE
WOOD FENCE
BARBED WIRE FENCE

Arbor Land Consultants, Inc.
Professional Land Surveyors
2936 Madrona Ct.
Ann Arbor, MI 48103
Tel 1-734-669-2960
Fax 1-734-669-2961

DATE: 11-25-2011
REVISION: 10-03-2013

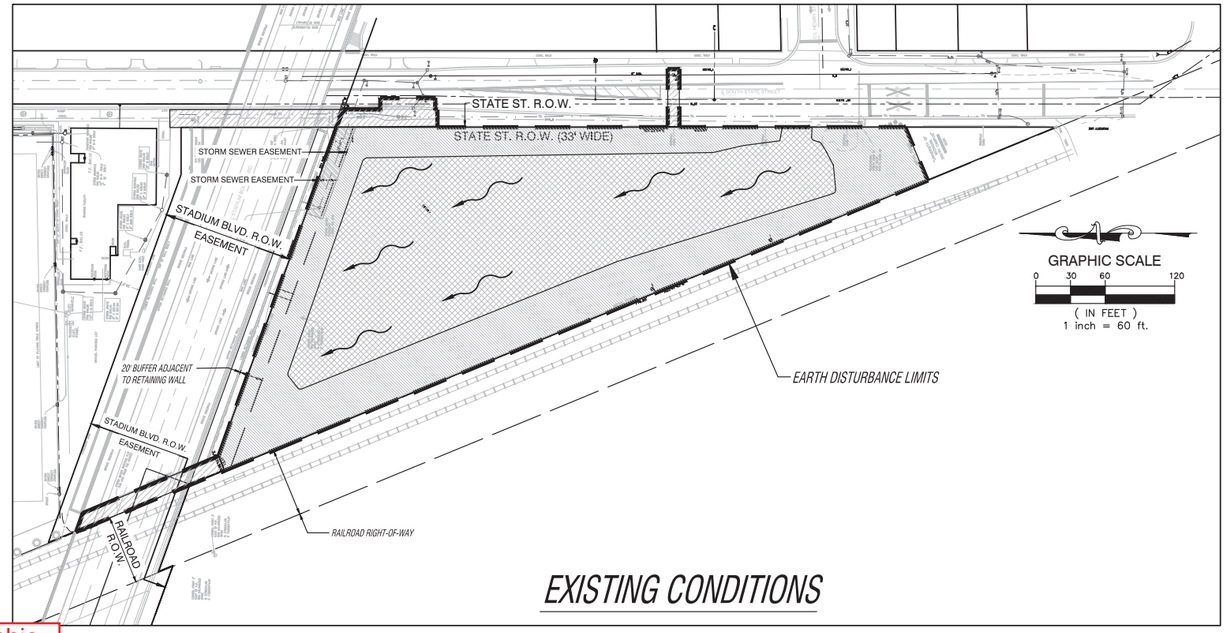
CLIENT: UNIVERSITY OF MICHIGAN

RED LOT PARKING AREA
TOPOGRAPHICAL SURVEY
S. STATE ST. @ STADIUM BLVD.
SECTION 32, T2S, R6E,
CITY OF ANN ARBOR
MICHIGAN

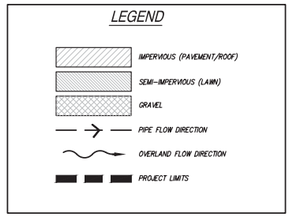
JOB No. 10912/03813/J1313
SHEET 8 OF 8
SCALE 1 INCH = 20 FEET

Paul Schreiner

C001C

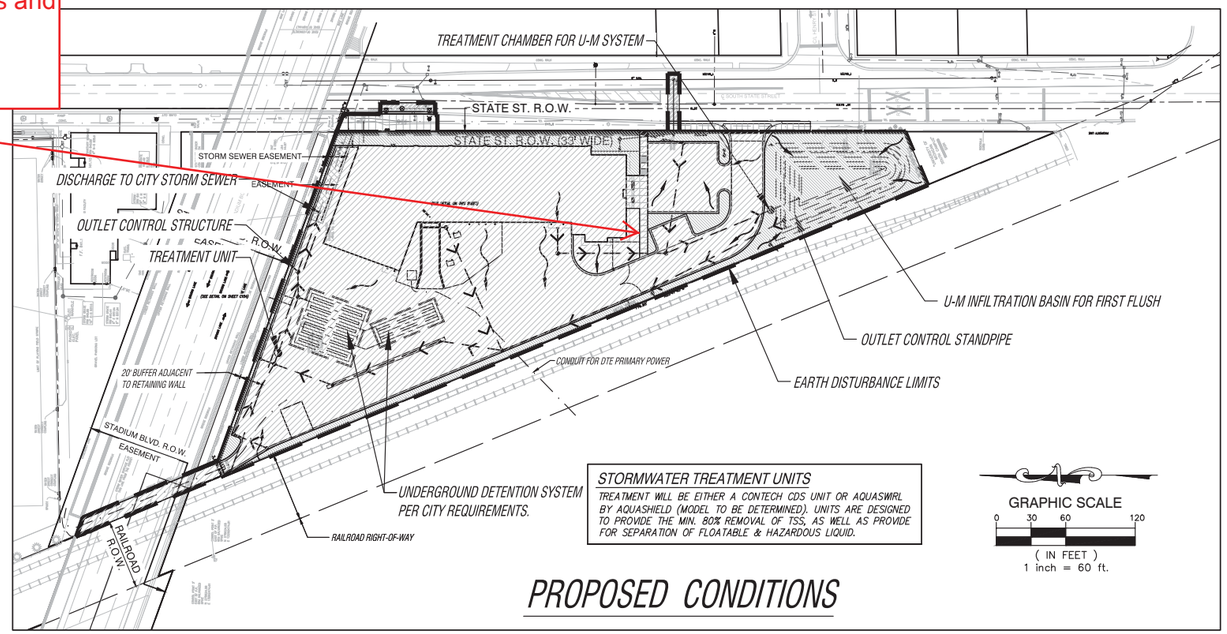


EXISTING CONDITIONS

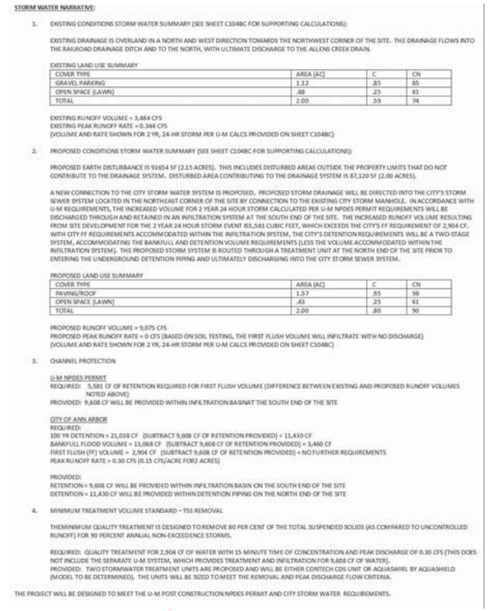


- Storm water sheet.
- Show drainage patterns of proposed and existing conditions with different hatching based on imperviousness. (See Campus Planning level of detail provided on U-M property)
-Provide narrative summarizing storm water as noted below.

Adjust this graphic to provide hatching of surface based on imperviousness and remove site paving details



PROPOSED CONDITIONS



STORM WATER NARRATIVE:

1. EXISTING CONDITIONS STORM WATER SUMMARY (SEE SHEET C104BC FOR SUPPORTING CALCULATIONS):

EXISTING DRAINAGE IS OVERLAND IN A NORTH AND WEST DIRECTION TOWARDS THE NORTHWEST CORNER OF THE SITE. THE DRAINAGE FLOWS INTO THE RAILROAD DRAINAGE DITCH AND TO THE NORTH, WITH ULTIMATE DISCHARGE TO THE ALLENS CREEK DRAIN.

EXISTING LAND USE SUMMARY

COVER TYPE	AREA (AC)	C	CN
GRAVEL PARKING	1.12	.85	85
OPEN SPACE (LAWN)	.88	.25	61
TOTAL	2.00	.59	74

EXISTING RUNOFF VOLUME = 3,484 CFS
EXISTING PEAK RUNOFF RATE = 0.344 CFS
(VOLUME AND RATE SHOWN FOR 2 YR, 24-HR STORM PER U-M CALCS PROVIDED ON SHEET C104BC)

2. PROPOSED CONDITIONS STORM WATER SUMMARY (SEE SHEET C104BC FOR SUPPORTING CALCULATIONS):

PROPOSED EARTH DISTURBANCE IS 93654 SF (2.15 ACRES). THIS INCLUDES DISTURBED AREAS OUTSIDE THE PROPERTY LIMITS THAT DO NOT CONTRIBUTE TO THE DRAINAGE SYSTEM. DISTURBED AREA CONTRIBUTING TO THE DRAINAGE SYSTEM IS 87,120 SF (2.00 ACRES).

A NEW CONNECTION TO THE CITY STORM WATER SYSTEM IS PROPOSED. PROPOSED STORM DRAINAGE WILL BE DIRECTED INTO THE CITY'S STORM SEWER SYSTEM LOCATED IN THE NORTHEAST CORNER OF THE SITE BY CONNECTION TO THE EXISTING CITY STORM MANHOLE. IN ACCORDANCE WITH U-M REQUIREMENTS, THE INCREASED VOLUME FOR 2 YEAR 24 HOUR STORM CALCULATED PER U-M NPDES PERMIT REQUIREMENTS WILL BE DISCHARGED THROUGH AND RETAINED IN AN INFILTRATION SYSTEM AT THE SOUTH END OF THE SITE. THE INCREASED RUNOFF VOLUME RESULTING FROM SITE DEVELOPMENT FOR THE 2 YEAR 24 HOUR STORM EVENT 85,581 CUBIC FEET, WHICH EXCEEDS THE CITY'S FF REQUIREMENT OF 2,904 CF. WITH CITY FF REQUIREMENTS ACCOMMODATED WITHIN THE INFILTRATION SYSTEM, THE CITY'S DETENTION REQUIREMENTS WILL BE A TWO-STAGE SYSTEM, ACCOMMODATING THE BANKFULL AND DETENTION VOLUME REQUIREMENTS (LESS THE VOLUME ACCOMMODATED WITHIN THE INFILTRATION SYSTEM). THE PROPOSED STORM SYSTEM IS ROUTED THROUGH A TREATMENT UNIT AT THE NORTH END OF THE SITE PRIOR TO ENTERING THE UNDERGROUND DETENTION PIPING AND ULTIMATELY DISCHARGING INTO THE CITY STORM SEWER SYSTEM.

PROPOSED LAND USE SUMMARY

COVER TYPE	AREA (AC)	C	CN
PAVING/ROOF	1.37	.95	98
OPEN SPACE (LAWN)	.40	.25	61
TOTAL	2.00	.80	90

PROPOSED RUNOFF VOLUME = 9,075 CFS
PROPOSED PEAK RUNOFF RATE = 0 CFS (BASED ON SOIL TESTING, THE FIRST FLUSH VOLUME WILL INFILTRATE WITH NO DISCHARGE)
(VOLUME AND RATE SHOWN FOR 2 YR, 24-HR STORM PER U-M CALCS PROVIDED ON SHEET C104BC)

3. CHANNEL PROTECTION

U-M NPDES PERMIT
REQUIRED: 5,581 CF OF RETENTION REQUIRED FOR FIRST FLUSH VOLUME (DIFFERENCE BETWEEN EXISTING AND PROPOSED RUNOFF VOLUMES NOTED ABOVE)
PROVIDED: 9,608 CF WILL BE PROVIDED WITHIN INFILTRATION BASIN AT THE SOUTH END OF THE SITE

CITY OF ANN ARBOR
REQUIRED:
100 YR DETENTION = 21,038 CF (SUBTRACT 9,608 CF OF RETENTION PROVIDED) = 11,430 CF
BANKFULL FLOOD VOLUME = 13,068 CF (SUBTRACT 9,608 CF OF RETENTION PROVIDED) = 3,460 CF
FIRST FLUSH (FF) VOLUME = 2,904 CF (SUBTRACT 9,608 CF OF RETENTION PROVIDED) = NO FURTHER REQUIREMENTS
PEAK RUNOFF RATE = 0.30 CFS (0.15 CFS/ACRE FOR 2 ACRES)

PROVIDED:
RETENTION = 9,608 CF WILL BE PROVIDED WITHIN INFILTRATION BASIN ON THE SOUTH END OF THE SITE
DETENTION = 11,430 CF WILL BE PROVIDED WITHIN DETENTION PIPING ON THE NORTH END OF THE SITE

4. MINIMUM TREATMENT VOLUME STANDARD – TSS REMOVAL

THE MINIMUM QUALITY TREATMENT IS DESIGNED TO REMOVE 80 PER CENT OF THE TOTAL SUSPENDED SOLIDS (AS COMPARED TO UNCONTROLLED RUNOFF) FOR 90 PERCENT ANNUAL NON-EXCEEDENCE STORMS.

REQUIRED: QUALITY TREATMENT FOR 2,904 CF OF WATER WITH 15 MINUTE TIME OF CONCENTRATION AND PEAK DISCHARGE OF 0.30 CFS (THIS DOES NOT INCLUDE THE SEPARATE U-M SYSTEM, WHICH PROVIDES TREATMENT AND INFILTRATION FOR 9,608 CF OF WATER).
PROVIDED: TWO STORMWATER TREATMENT UNITS ARE PROPOSED AND WILL BE EITHER CONTECH CDS UNIT OR AQUASWIRL BY AQUASHIELD (MODEL TO BE DETERMINED). THE UNITS WILL BE SIZED TO MEET THE REMOVAL AND PEAK DISCHARGE FLOW CRITERIA.

THE PROJECT WILL BE DESIGNED TO MEET THE U-M POST CONSTRUCTION NPDES PERMIT AND CITY STORM WATER REQUIREMENTS.

Storm water narrative

REFER TO SHEETS C104AC AND C104BC FOR SYSTEM LAYOUT, DETAILS AND CALCULATIONS

THE UNIVERSITY OF MICHIGAN
Architecture, Engineering and Construction
University Architect's Office
326 E. Hoover Ave.
Mail Stop E
ANN ARBOR, MICHIGAN 48109-1002

NIAGARA MURANO ARCHITECTURE
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TELEPHONE: 248.646.5765
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Architect's Project No. - 13144.0

Spalding DeDecker Associates, Inc.
Engineering Consultants
Infrastructure • Land Development • Surveying
905 South Blvd. East
Rochester Hills, MI 48307
Phone: (248) 844-5400
Fax: (248) 844-5404
www.sda-eng.com
(800) 598-1600
SDA Project No. - NP13033

issue:	date:
City Site Plan Review	April 28, 2014
Prelim. City Site Plan Review	April 25, 2014
Prelim. City Site Plan Review	March 19, 2014
Owner Review - City Submitted	February 19, 2014
DD Review	December 20, 2013
SD Review	November 27, 2013
Owner Review #2	November 7, 2013
Owner Review	October 24, 2013

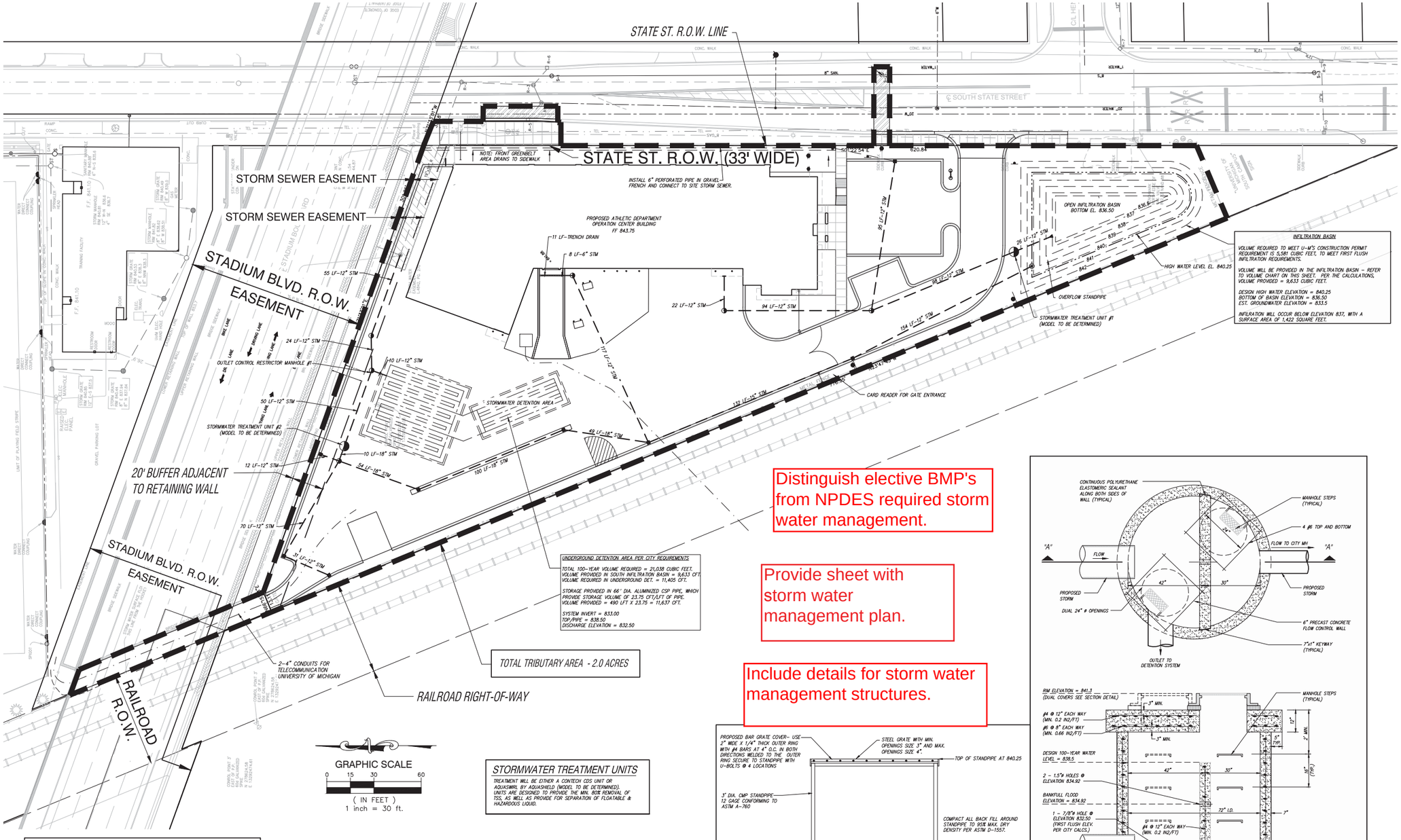
University of Michigan

submitted to: HFES	NO	BFS:	NO
AEC constr mgmt no.			P00008399
building no.			-
designed			T. Sovel
drawn			J. Ensley
coordination checked			T. Sovel
checked	T. Sovel	approved	T. Sovel
um design manager			
location			UM Athletics Ops Center
keywords			

project:
UM Athletics Department Operations Center

sheet title:
Storm Water Management Plan Summary Sheet

project number: UM AEC : P00008399
sheet number: C104C



Distinguish elective BMP's from NPDES required storm water management.

Provide sheet with storm water management plan.

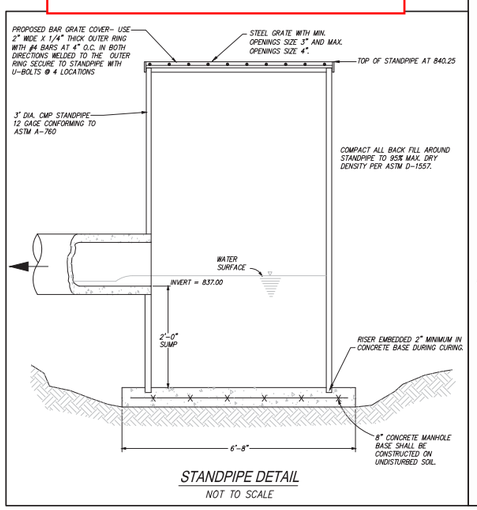
Include details for storm water management structures.

LEGEND

- PROPOSED WATERMAIN
- PROPOSED SANITARY
- PROPOSED STORM SEWER
- PROPOSED GAS MAIN
- PROPOSED ELECTRIC
- PROPOSED HYDRANT
- PROPOSED GATE VALVE & WELL (GVW)
- PROPOSED TAPPING SLEEVE, VALVE & WELL (TSVW)
- PROPOSED SAN MANHOLE (SAN)
- PROPOSED STORM MANHOLE (MH)
- PROPOSED CATCH BASIN (CB)
- PROPOSED INLET (INL)
- PROPOSED END SECTION (ES)
- PROPOSED FIELD CATCH BASIN (FCB) W/BEEHIVE COVER OR STANDPIPE (SP) W/ BAR GRATE COVER
- STANDARD BITUMINOUS PAVEMENT
- HEAVY-DUTY BITUMINOUS PAVEMENT
- DEEP-STRENGTH BITUMINOUS PAVEMENT
- CONCRETE PAVEMENT
- CONCRETE SIDEWALK
- MILL PAVEMENT
- 2 — UTILITY CROSSING (SEE DATA TABLE)
- STORM SEWER STRUCTURE: CB 2 — STRUCT. TYPE / STRUCT. NO.
- SANITARY SEWER STRUCTURE: 20
- WATERMAIN STRUCTURE: 10 / XXX — STRUCT. NO. / STRUCT. TYPE

INFILTERATION BASIN VOLUME

Contour (FT)	Area (SFT)	Volume (CFT)	Total Storage Volume (CFT)	
840.25	4590.85	1111.44	9,632.79	
840.00	4300.64	3758.92	8,521.35	
839.00	3217.20	2737.39	4,762.43	
838.00	2257.57	1839.67	2,025.05	
837.00	1421.76	617.94	185.38	(30% void)
836.50	1050.00			
(NOTE: VOLUME BETWEEN 836.50 AND 837.00 WILL BE FILLED WITH STONE)				
Volume Provided =		9,632.79	cft	
Design water depth =		3.75	ft	



STANDPIPE DETAIL
NOT TO SCALE

SECTION A-A

NOTE: THE PRECAST REINFORCED OUTLET CONTROL STRUCTURE SHALL BE MANUFACTURED TO ASTM C-478 SPECIFICATIONS.

OUTLET CONTROL STRUCTURE #1 DETAIL
N.T.S.

THE UNIVERSITY OF MICHIGAN
Architecture, Engineering and Construction
University Architect's Office
326 E. Hoover Ave.
Mail Stop E
ANN ARBOR, MICHIGAN 48109-1002

NIAGARA MURANO ARCHITECTURE
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issue:	date:
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University of Michigan

submitted to: HFES	NO	BFS:	NO
AEC constr mgmt no.		P00008399	
building no.			-
designed		T. Sovel	
drawn		J. Ensley	
coordination checked		T. Sovel	
checked	T. Sovel	approved	T. Sovel
um design manager			
location		UM Athletics Ops Center	
keywords			

project:
UM Athletics Department Operations Center

sheet title:
Storm Water Management Plan

project number: UM AEC : P00008399

sheet number: C104AC

Detention Basin Design

(Washtenaw County Water Resources Commissioner)

Total Area Tributary (A_T) = 2.00

Area Label	A	C	A*C
Pavement	1.11	0.95	1.05
Lawn	0.43	0.25	0.11
Flat Roof	0.46	0.95	0.44
Sum	2.00	2.15	1.60
Overall weighted C factor			0.80

Enter Standard Allowable Discharge (q, cfs/acre): **0.15**

Overall runoff coefficient (C): **0.80**

Overall site acreage contributing to the basin (A): **2.00** **Ac.**

*Maximum allowable outflow, Qmax (q * A):* **0.30** **CFS**

100-Year Flood Volume Required

Q_A = [(allowable outflow, Q_A) / (acreage)(runoff coefficient)]

Q_A = 0.19 CFS/(acre*imperviousness)

Storage time calculation:

T = -25 + sqrt(10,312.5 / Q_A) (100 year storm)

T = 208.0 min.

Maximum volume of storage per acre imperviousness:

V_A = (16,500 (T) / (T + 25)) - 40(Q_A)(T) (100 year storm)

V_A = 13148.8 CF/(acre*imperviousness)

Total volume of storage required for the entire site:

V_T = (V_A)(site acreage)(runoff coefficient)

V_T = 21,038 cf

Bankfull Flood Volume

The bankfull storm is defined as the 24 hour, 1.5-year storm event:

V_{BF} = (2.25"x(1/12")(43,560sf/1 ac) AC

V_{BF} = 2,904 cf

First Flush Volume

The first flush storm is defined as the first 0.5" of rain over the entire watershed.

V_{FF} = (0.5"x(1/12")(43,560sf/1 ac) AC

V_{FF} = 2,904 cf

Storage Provided for 100-Year Storm

To meet the UM requirements, **9,633** cubic feet of storage is provided in the infiltration system for the first flush storm, computed for the 2-year, 24 hour storm event. Therefore, total storage required in the City detention system= 21038.9633= 11,405 cubic feet

Storage is provided in 66" diameter aluminized CSP, which provide 23.75 CFT per LFT of pipe

Therefore, 11405 / 23.75 = 480 LFT of 66" diameter pipe.

Refer to calculations below for storage elevations of first flush and bank full volumes.

Storage Elevations

First Flush:

Per calculations above, 2,904 cubic feet is required for first flush volume.

Per U-M first flush requirements, 5,581 cubic feet of storage is required, and we are providing 9633 cubic feet.

Therefore, first flush volume requirements are met in the infiltration system.

Bankfull:

Bankfull volume can be reduced by first flush volume in UM system = 13068 - 9633 = 3,435 CFT

Bank full flood volume= 3,435 X_{BF} = 834.92

The volume provided at 23" above invert is 7.3 CFT/LFT (approx. 834.9)

CFT/LFT of pipe. Therefore, for a length of 480 LFT

The total volume provided is 3,506 CFT

Invert of the system = 833.00

Base Flood Elevation = 834.92

100 year:

The volume for the 100-year storm is provided at the top of the system. X_{100} = 838.50 (approx. 838.5)

Outlet Control Structure

First flush of runoff:

City of AA standards require that the first flush volume be able to infiltrate. From U-M calculations above, we are infiltrating a volume of 9633 cft, far in excess of the City requirement. This volume is being infiltrated in the retention/infiltration system at the south end of the site.

According to the infiltration testing, an infiltration rate of 1.4 inches per hour is appropriate at the west and south areas of the site in the vicinity of borings B1, B2, and B4. We can use Darcy's Law to estimate the infiltration time for this volume of water.

Darcy's Law, V = AkT

where: V = Volume of water, CFT

A = Area of infiltration, SFT = 1,422 square feet ** see note below

k = infiltration rate, in. per hr = 1.4 in/hour = 0.12 ft/hour

T = time, hours

** - footprint of infiltration area at bottom of basin = 1,400 SFT

Solving for Time, Darcy's Law becomes:

T = V/(A*k)

Therefore, for the volume of 2,904 cubic feet calculated above, the time will be:

T = 2904 / (1422)(0.12)

T = 17.0 hours

Ideal infiltration is anything less than 24 hours.

Bankfull flood:

The bankfull flood must be detained 36-48 hours; discharge will be through holes in the restrictor manhole, in the wet wall, at the first flush elevation. Since first flush is handled in the U-M retention system, set first flush elevation at the outlet elevation of the system.

Xf = 832.50

h_{avg} = 2/3 (elev. $_{bf}$ - elev. $_{ff}$) = 2/3 (834.92-832.5)

h_{avg} = 1.61 ft

To target a detention time of 36 hours, compute the flow rate, Q, to discharge the bank full flood volume:

$T = V_{BF} / Q$, solve for Q = Vb/ft, where V= 3,435 and t = 36 hrs.

(note - volume references city requirement less UM volume)

= 3,435 / 36 = 95.42 cf/hr or 0.027 cfs

Now compute orifice sizing to achieve 0.027 CFS

$Q = 0.62 * A_{ff} * \text{sqrt}(2*g*h_{avg})$, solve for Aff

Aff = 0.0042 SFT = 0.60 square inches

Solving for radius gives 0.438 inches, or 0.88 inch diameter hole

to be set at the first flush elev., or outlet elev. of the system = 832.50

Since the 0.88 in. dia. hole is not a standard dimension, use 0.875 (7/8) inch

This gives an actual area of 0.0042 square feet so the calculations below will use this area.

100-year flood:

Q_A = 0.30 cfs (using 0.15 cfs/acre)

Q_A is a peak or maximum flow. Calculate the maximum flow passing through the bankfull orifice, using the total head, and subtract from Q_A to determine the additional orifice size to release the 100-year storm volume:

$Q_{BF} = 0.62 * A_{BF} * \text{sqrt}(2*g*h_{bf}{}^{BF})$ $h_{bf}{}^{BF}$ = 6.0

A_{BF} = 0.0042

Q_{BF} = 0.05 cfs

$Q_{100} = Q_A - Q_{BF}$ (this is the additional flow required to achieve the 0.3 cfs max outflow)

Q_{100} = 0.25 cfs

Compute orifice area at the bank full elevation to attain the add'l 0.25 cfs.

$A_{100} = Q_{100} / (0.62 * \text{sqrt}(2*g*h_{100}))$ where h_{100}= 3.58 feet from 100-year water level to bank full level

A_{100} = 0.026 sf

A 1.5" diameter orifice has an area of 0.0123 sf

= A_{100} / area per orifice

= 2.15

Therefore, use 2 - 1.5" diameter holes @ elev. 834.92

Calculation of Detention Volume Discharge Time

First, calculate discharge time from 100-year HWL (838.5) to bank full elevation (834.92) through the holes at the bankfull elevation.

h_{avg} = 2/3 (elev. $_{100}$ - elev. $_{bf}$) elev. $_{100}$ = 838.50

h_{avg} = 2.39 ft elev. $_{bf}$ = 834.92

$Q = 0.62 * A * \text{sqrt}(2*g*h_{avg})$

A = 0.0264

Q_{100} = 0.20 cfs (discharge rate through holes at bank full elev)

Next, calculate discharge through the holes at the discharge elevation (832.5) between the 100-year level (838.5) and bank full level (834.92)

Average water level = 837.31 Average head = 837.31 - 832.5= 4.81

$Q = 0.62 * A * \text{sqrt}(2*g*h_{avg})$

A = 0.0042

Q_{100} = 0.05 cfs (discharge rate through discharge hole at 832.5)

Total discharge rate between elevation 838.5 and 834.92 = 0.25 CFS.

In the detention system, the volume stored between 838.5 and 834.92 over 480 LFT is 8,186 CFT

The time to drain 8186 CFT at a rate of 0.25 CFS = 32,877 SEC = 9.1 HRS

Next, calculate discharge time from bank full elev (834.92) to discharge level (832.5) through discharge hole

h_{avg} = 2/3 (elev. $_{bf}$ - elev. $_{discharge}$) elev. $_{bf}$ = 834.92

h_{avg} = 1.61 ft elev. $_{discharge}$ = 832.50

$Q_{100} = 0.62 * A_{discharge} * \text{sqrt}(2*g*h_{avg})$

$A_{discharge}$ = 0.0042

Q_{100} = 0.03 cfs

In the detention system, the volume stored between 834.92 and 832.5 over 480 LFT is 3,219 CFT

The time to drain 3219 CFT at a rate of 0.03 CFS = 121,276 SEC = 33.7 HRS

Total time to drain the detention system = 9.13 + 33.69 = 42.8 Hours

UNIVERSITY OF MICHIGAN
OSEH REQUIREMENTS FOR STORMWATER MANAGEMENT

1.1 Minimum Treatment Volume Standard

The minimum treatment volume standard shall be based on the 90 percent annual non-exceedance storm, which is dictated in the MDEQ 2006 memo.

The 90% Annual Non-Exceedence Storm for this area, P = 0.9 inches

Total Disturbed Area, A = 2.00 acres

Use the Small Storm Hydrology Method to compute a volumetric runoff coefficient (Rv) based on the specific characteristics of the pervious and impervious surfaces of the drainage catchment.

Area Type	A (acre)	Rv	A*Rv
Silty Soils (HSG-B)	0.46	0.11	0.05
Impervious Paving	1.11	0.97	1.08
Flat Roof	0.43	0.84	0.36
Sum	2.00		1.49
Weighted Volumetric Runoff Coefficient, Rv:			**0.75**

Water Quality Volume, WQV = P x Rv x A

WQV = 0.9 inches x 0.75 x 2 acres x 1ft/12in x 43,560sft/acre

WQV = 4901 cft (Minimum Treatment Volume)

Estimating Peak Discharge for the Water Quality Storm
Solve for the curve number, CN.

$CN = 1000/[10 + 5P + 10Q - 10(Q^2 + 1.25QP)^{1/2}]$

Where Q = P x Rv = 0.9 x 0.75 = 0.68 inches

CN = 1000/[10 + 5(0.9) + 10(0.68) - 10((0.68)2 + 1.25(0.68)(0.9))1/2]

CN = 98

Solve for the Peak Discharge, Qp

Given the CN calculated above, Ia = 0.041 in (TR-55, Table 4-1)

The drainage area is equal to the disturbed area = 0.00313 sq. mi.

Appropriate rainfall distribution type Type II

Ia/P = 0.05

Given the Ia/P and Tc of 15 minutes, Unit Peak Discharge, qu = 750 csm/in (TR-55, Exhibit 4-II)

Qp = qu x A x Q

Qp = 750 x 0.00313 x 0.68 = 1.6 cfs (Peak Discharge for Water Quality Storm)

1.2 Minimum Treatment Volume Standard - TSS Removal

The U-M requirement is that a minimum of 80 percent removal of total suspended solids (TSS), as compared with uncontrolled run-off, is required for post-development. This will be accomplished through the use of two stormwater treatment units, one at the south infiltration area, and one at the north side of the site prior to discharge into the City storm system. The units will be either a CDS unit by Stormtech, or an AquaSwirl unit by AquaShield (model to be determined). Both units provide the required 80% TSS removal, as well as providing separation of floatables and hazardous liquids (oil, gas, etc.).

2.0 - 2.2 Channel Protection Criteria, Rainfall Data, and Methods for estimating pre-and post development runoff

The channel protection criteria must maintain post-development site runoff volume and peak flow rate at or below existing levels for all storms up to the 2-year, 24-hour event. "Existing levels" means the runoff volume and peak flow rate for the last land use prior to the planned new development or redevelopment.

The rainfall data for calculating runoff volume and peak flow rate shall be the *Rainfall Frequency Atlas of the Midwest*, 1992 (NOAA - Huff & Angel).

The methods used for estimating pre- and post development runoff shall follow curve number evaluations as described in MDEQ's *Computing Flood Discharges from Small Ungaged Watersheds*, June 2008.

	Area (sft)	Area (acres)
Disturbed Area of Site		2
Estimated Watershed Area (i.e. area of site)	87120	2
Existing Impervious Area in Watershed	0	0
Existing Gravel Area	49022	1.13
Proposed Impervious Area in Watershed	67082	1.54
Change in Impervious Area in Watershed	67082	1.54

Existing Conditions

Hydrologic Soil Group	Percent of Total Drainage Area	Land Use	Percent of Soil Group	RCN	Partial RCN
B	100	Lawn Area	44	61	26.84
		Gravel Areas	56	85	47.6
				Sum	74

Proposed Conditions:

Hydrologic Soil Group	Percent of Total Drainage Area	Land Use	Percent of Soil Group	RCN	Partial RCN
B	100	Lawn Area	23	61	14.03
		Impervious Area	77	98	75.46
				Sum	89

Calculate Surface Runoff (SRO)

SRO = (P-0.2S)^2 / (P+0.8S)^2

where P = 2 Year, 24 hour rainfall (inches) = 2.26 inches for Ann Arbor

and S = Potential Maximum Retention after Runoff Begins, inches

S = (1000/RCN) - 10

Therefore, computing S for both existing and proposed conditions:

Sx = 3.51 inches

Sp = 1.24 inches

Now calculate SRO for both existing and proposed conditions:

SROx = 0.48 inches

SROp = 1.25 inches

Runoff Increase = 0.77 inches

The drainage area of the site is 87,120 square feet. The required retention volume is based on the increase in runoff from existing to proposed condition. For these sites, that will be 0.77 inches. Therefore, the retention volume is:

Volume = A x (SROp-SROx) / 12" / foot

Volume = 5,581 cubic feet

Storage volume to meet U-M requirements is provided in the open retention/infiltration basin at the south end of the site. Volume is provided between the bottom elevation of 836.50 and the storage elevation of 840.25. Total volume provided is **9,633** cubic feet (refer to volume chart on the plans)

FLOW CALCULATION FOR EXISTING DISCHARGE

TR-55 procedures will be utilized to estimate the discharge from the existing site. Utilizing the flow chart in Figure 1-1, it can be determined that the Graphical Peak Discharge Method should be used.

The first step is to compute the watershed runoff, "Q", per Chapter 2 in TR-55.

The SCS runoff curve number method is used to compute the runoff as follows:

Q = (P-0.2S)^2 / (P+0.8S) where Q = runoff (in), P = rainfall (in), and S= potential max retention after runoff begins. S is computed as:

S = (1000/CN)-10 = 3.51 inches

P for the 2 year, 24 hour storm is 2.26 inches for Ann Arbor.

Therefore, Q is equal to: 0.479 inches

The second step is to compute the time of concentration, Tc for the watershed. This is done utilizing the methods indicated in Chapter 3. The existing drainage on this site is from south to north, via sheet flow. Per TR-55, time of concentration for sheet flow should only be computed over a maximum length of 300', after which the surface runoff should be treated as shallow, concentrated flow. The computation for Tc using the two zones follows:

Tc for sheet flow = 0.007(nL)^0.8 / ((P2)^0.5 * s^0.4), where n = Manning's coefficient of roughness, L = length of travel, P = 2 year, 24 hour rainfall (inches), and s = slope of the land.

Tc for shallow, concentrated flow = L/(3600*V), where L = length of travel, and V is determined from Figure 3-1 in TR-55 based on the slope of the land and type of surface.

Time of Concentration, Tc, for Existing Conditions

Type of Flow	Length (ft)	Change in Elevation (ft)	Slope (ft/ft)	Manning "n"	Velocity (fps)	Incremental Tc (hrs)
Sheet Flow	300	1.0	0.0033	0.24	N/A	1.40
Shallow Flow	360	1.8	0.0050	n/a	1.18	0.08
					Total Tc	1.48

The third step is to compute the peak discharge using the Graphical Peak Discharge Method, described in Chapter 4 of TR-55.

The peak discharge, Qp = Qu x Am x Q x Fp, where:

Qp = peak discharge, CFS

Qu = unit peak discharge, csm/in

Am = drainage area, mi^2 = 0.003125 square miles

Q = runoff, in, as computed above

Fp = pond adjustment factor (N/A for this project)

Qu, unit peak discharge, is based on the values of Ia, P, and the CN.

Using Table 4-1 in TR-55, the initial abstraction, Ia, for a CN of 74 is 0.703 inches.

The 24-hour rainfall for the 2-year event is 2.26 inches

Therefore, Ia/P is computed as: 0.311

Now utilizing the value of Ia/P and the Tc computed above, we utilize the graph in Exhibit 4-II to determine Qu for the Type II rainfall distribution. The graph indicates a value of 230 csm/in

Therefore, Qp for existing conditions = 0.344 CFS

FLOW CALCULATION FOR PROPOSED DISCHARGE

In addition to limiting the volume of runoff to the pre-development 2 year, 24-hour storm, the discharge rate/velocity for post-development must also not exceed the pre-development numbers.

Based on the Flow Calculation for Existing Discharge above, the existing discharge from the site is 0.344 CFS.

Per City of Ann Arbor requirements, the discharge from the system will be restricted to 0.15 CFS/acre up to the 100-year storm. The total tributary area is 2 acres, and therefore our max discharge under design conditions is 0.30 CFS, which is less than the 0.344 CFS existing discharge.

It should be noted that the discharge rate from the system for the 2-year, 24-hour storm will be completely eliminated, since the discharge for the 2 year, 24-hour storm will now infiltrate.

STORMWATER SYSTEM DISCHARGE PER U-M REQUIREMENTS

Discharge to meet the UM requirement is proposed via infiltration through the sand/gravel soils on the site. The infiltration zone is proposed at the south end of the site, where infiltration based on testing is at it's highest level of 9.4 inches per hour. SME recommends an infiltration rate of 1.4 inches per hour at the west and south parts of the site, which takes into account a significant factor of safety for clogging of the soils.

We propose an open infiltration basin at the south end of the site. The design provides a surface area at the 837 contour of 1,422 square feet for the infiltration zone.

Darcy's Law will be used to calculate the time need to fully infiltrate the channel protection volume.

Darcy's Law, V = AkT

where: V = Volume of water, CFT = 5,581 CFT

A = Area of infiltration, SFT = 1,422 square feet

k = infiltration rate, inches per hour = 1.4 in/hour = 0.12 ft/hour

T = time, hours

Solving for Time, Darcy's Law becomes:

T = V/(A*k)

Therefore, for the volume of 5,581 cubic feet calculated above, the time will be:

T = 5581 / (1422)(0.12)

T = 32.7 hours

Infiltration must infiltrate between 24 and 48 hours, so this is acceptable.

Provide calculation sheet.

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City Site Plan Review	April 28, 2014
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University of Michigan

submitted to: HFES	NO	BFS:	NO
AEC constr mgmt no.	P00008399		
building no.	-		
designed	T. Sovel		
drawn	J. Ensley		
coordination checked	T. Sovel		
checked	T. Sovel	approved	T. Sovel
um design manager			
location	UM Athletics Ops Center		
keywords			

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