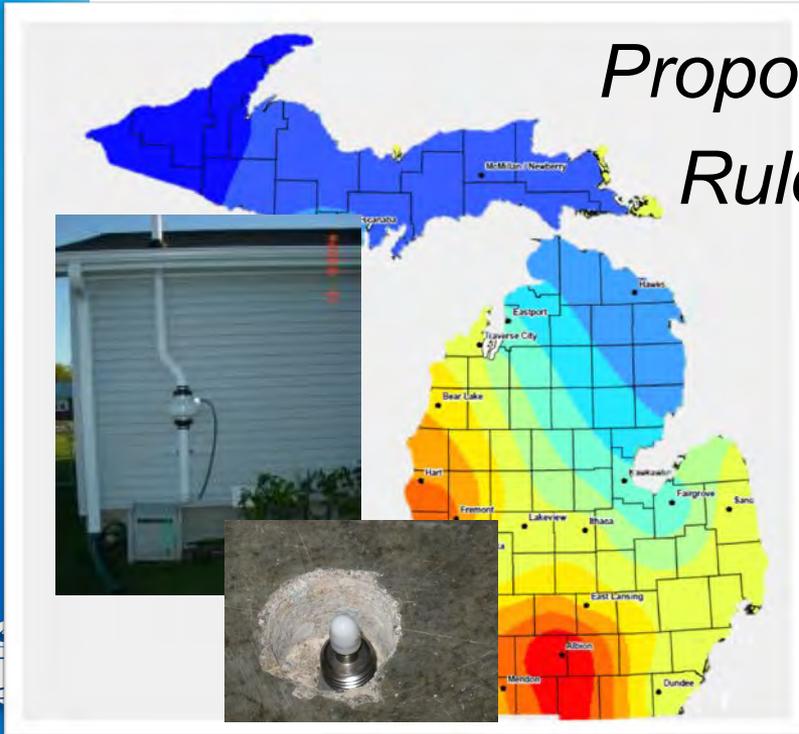


Facility-Specific Soil Type and Temperature and Volatilization to Indoor Air Pathway

Proposed Part 201

Rule 7 and 27



Matthew Williams

Vapor Intrusion Specialist

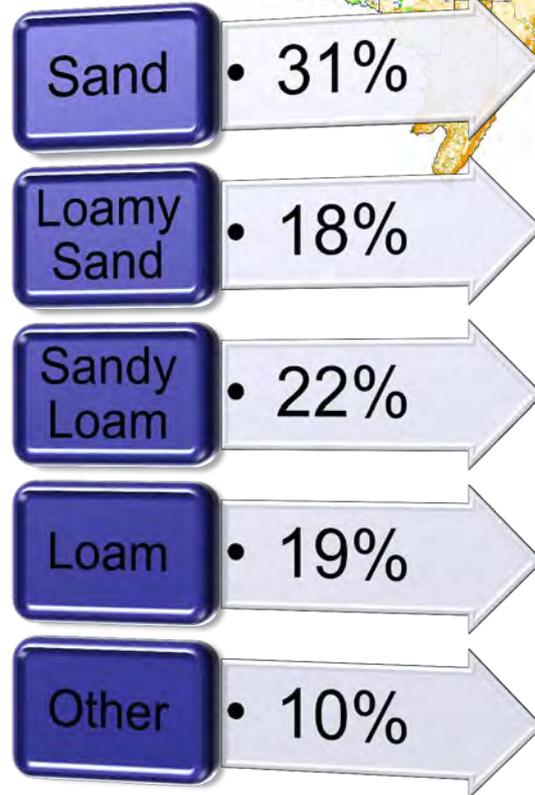
Remediation & Redevelopment Division

williamsm13@michigan.gov

Rule 7

- Facility-specific inputs to develop generic criteria
- Allows for consistent use of soil-type assumptions
 - C_{sat}
 - Soil-Water Partitioning Values
 - Volatile Soil Inhalation and Particulate Soil Inhalation Criteria.
 - Volatilization to Indoor Air Criteria
- Michigan soil type used

USDA Soil Classifications



Soil Parameters

TABLE 2.
Generic Input Values for USDA Soil Conservation Service Soil Textural Classifications

Soil Texture (USDA)	Soil Texture Abbreviation (USDA)	Soil Total Porosity ^{AB} n (cm ³ /cm ³)	Saturated Water Content ^{AC} θ_s (cm ³ /cm ³)	Residual Water Content ^{AB} θ_r (cm ³ /cm ³)	Soil Water-Filled Porosity ^A θ_w (cm ³ /cm ³)	Soil Air-Filled Porosity ^{AD} θ_a (cm ³ /cm ³)	van Genuchten parameters ^{AB}			Mean Particle Diameter ^{AE} (cm)	Dry Bulk Density ^{AE} ρ_b (g/cm ³)	Saturated Hydraulic Conductivity ^A K_s (cm/h)
							α_1 (1/cm)	N	M			
Clay	C	0.459	0.459	0.098	0.215	0.244	0.01496	1.253	0.2019	0.0092	1.43	0.61
Clay loam	CL	0.442	0.442	0.079	0.168	0.274	0.01581	1.416	0.2938	0.016	1.48	0.34
Loam	L	0.399	0.399	0.061	0.148	0.251	0.01112	1.472	0.3207	0.02	1.59	0.5
Loamy sand	LS	0.39	0.39	0.049	0.076	0.314	0.03475	1.746	0.4273	0.04	1.62	4.38
Silt	SI	0.489	0.489	0.05	0.167	0.322	0.00658	1.679	0.4044	0.0046	1.35	1.82
Silty loam	SIL	0.439	0.439	0.065	0.18	0.259	0.00506	1.663	0.3987	0.011	1.49	0.76
Silty clay	SIC	0.481	0.481	0.111	0.216	0.265	0.01622	1.321	0.243	0.0039	1.38	0.4
Silty clay loam	SICL	0.482	0.482	0.09	0.198	0.284	0.00839	1.521	0.3425	0.0056	1.63	0.46
Sand	S	0.375	0.375	0.053	0.054	0.321	0.03524	3.177	0.6852	0.044	1.66	26.78
Sandy clay	SC	0.385	0.385	0.117	0.197	0.188	0.03342	1.208	0.1722	0.025	1.63	0.47
Sandy clay loam	SCL	0.384	0.384	0.063	0.146	0.238	0.02109	1.33	0.2481	0.029	1.63	0.55
Sandy loam	SL	0.387	0.387	0.039	0.103	0.284	0.02667	1.449	0.3099	0.03	1.62	1.6

A - From USEPA, 2004. *User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings*. United States Environmental Protection Agency, Office of Emergency and Remedial Response. February 22, 2004.

B - Hers, I. June 3, 2002 Technical Memorandum to Debbie Newberry, USEPA OSW. *Input Parameters for OSWER Wide Guidance for Vapor Intrusion Pathway*.

C - Saturated water content is assumed to be equal to the water soil total porosity because the saturated water between drainage and wetting conditions varies but is always less than the fully saturated water content which is equal to the soil total porosity.

D - The air-filled porosity is calculated as the total porosity minus soil water-filled porosity.

E - Nielson, K. K., and V. C. Rogers. 1990. Radon transport properties of soil classes for estimating indoor radon entry. In: F. T. Cross (ed), *Proceedings of the 29th Hanford Symposium of Health and the Environment. Indoor Radon and Lung Cancer: Reality or Myth? Part 1*. Battelle Press, Richland, Washington.

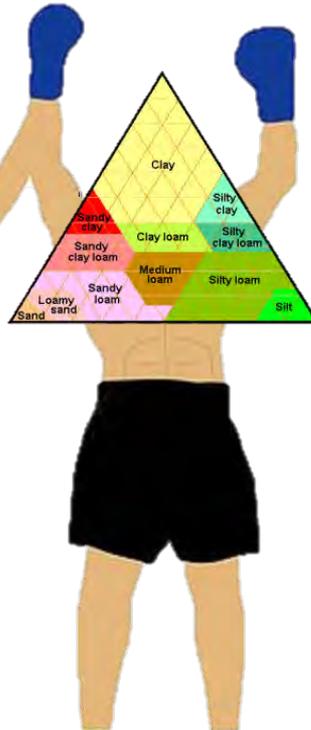
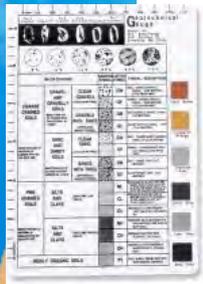
USDA Soil Classification

USCS

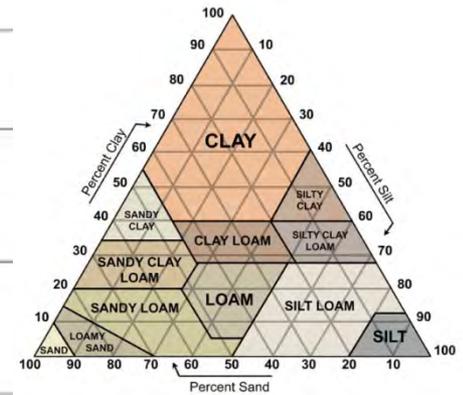
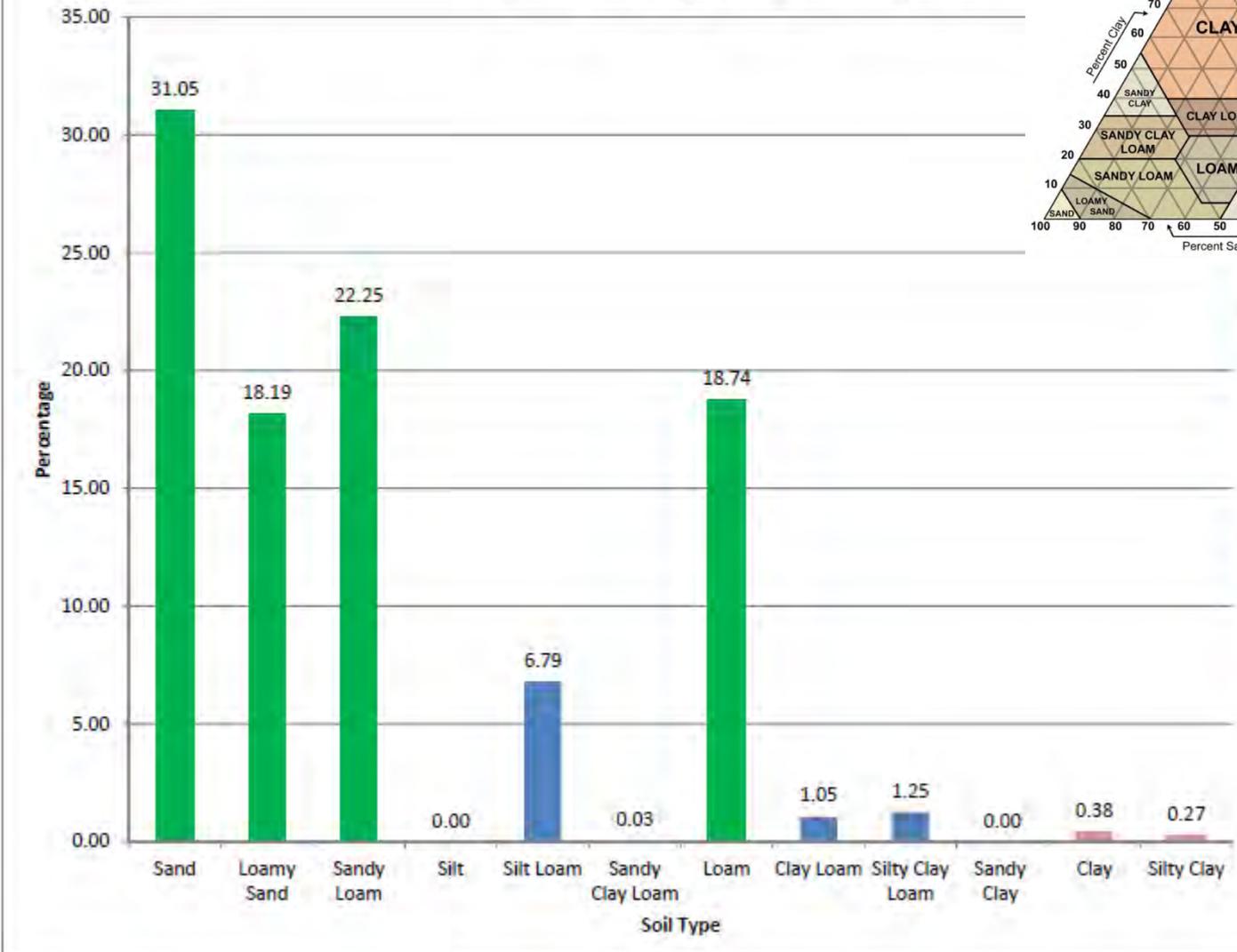
vs

USDA

- 12 soil types
 - Some do not occur
 - Not USCS
- Modifications based on:
 - Field examination
 - Lab analysis
- USDA Web Soil Survey



USDA Soil Types in Michigan



- Sand
- Loamy Sand
- Sandy Loam
- Silt
- Silt Loam
- Sandy Clay Loam
- Loam
- Clay Loam
- Silty Clay Loam
- Sandy Clay
- Clay
- Silty Clay

Temperature



- ▶ MSU Extension - Enviro-weather
- ▶ <http://enviroweather.msu.edu/homeMap.php>



Station: Mendon
Station ID: men
Location: Mendon Seed Groves
City: Mendon
Latitude: 41.9033 deg
Longitude: 85.4333 deg
Elevation: 288 m

Station: Paulsburg
Station ID: pr
Location: Clay Farms
City: Paulsburg
Latitude: 41.0001 deg
Longitude: 83.7011 deg
Elevation: 212 m

Station: Stephenson
Station ID: sv
Location: Meigs-Dowdy Extension
City: Stephenson
Latitude: 45.4802 deg
Longitude: 87.6298 deg
Elevation: 164

Station	Day	Min	Max	Humidity	Wind	Wind Dir	Wind Spd	Pressure	Temp	Unit
Stephenson	7/9/2015	20.2	25.2	%	0.1	°C	13.2	1013.2	13.2	°C
	7/9/2015	0.182	0.182	hPa	0.192	cm/hour	0.182	1013.2	0.182	cm/hour
	7/9/2015	0.159	0.159	hPa	0.169	cm/hour	0.159	1013.2	0.159	cm/hour
	7/9/2015	32.5	32.5	%	10.9	°C	8.1	1013.2	10.9	°C
	7/9/2015	45.5	45.5	%	9.4	°C	9.4	1013.2	45.5	°C
	7/9/2015	11.6	11.6	%	9.4	°C	9.4	1013.2	11.6	°C
	7/9/2015	49.3	49.3	%	9.4	°C	9.4	1013.2	49.3	°C
	7/9/2015	49.3	49.3	%	9.4	°C	9.4	1013.2	49.3	°C
	7/9/2015	49.3	49.3	%	9.4	°C	9.4	1013.2	49.3	°C
	7/9/2015	49.3	49.3	%	9.4	°C	9.4	1013.2	49.3	°C

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	7/9/2015	11.6	11.6	%	9.4	°C	9.4	1013.2	11.6	°C
	7/9/2015	49.3	49.3	%	9.4	°C	9.4	1013.2	49.3	°C
	7/9/2015	49.3	49.3	%	9.4	°C	9.4	1013.2	49.3	°C
	7/9/2015	49.3	49.3	%	9.4	°C	9.4	1013.2	49.3	°C
	7/9/2015	49.3	49.3	%	9.4	°C	9.4	1013.2	49.3	°C

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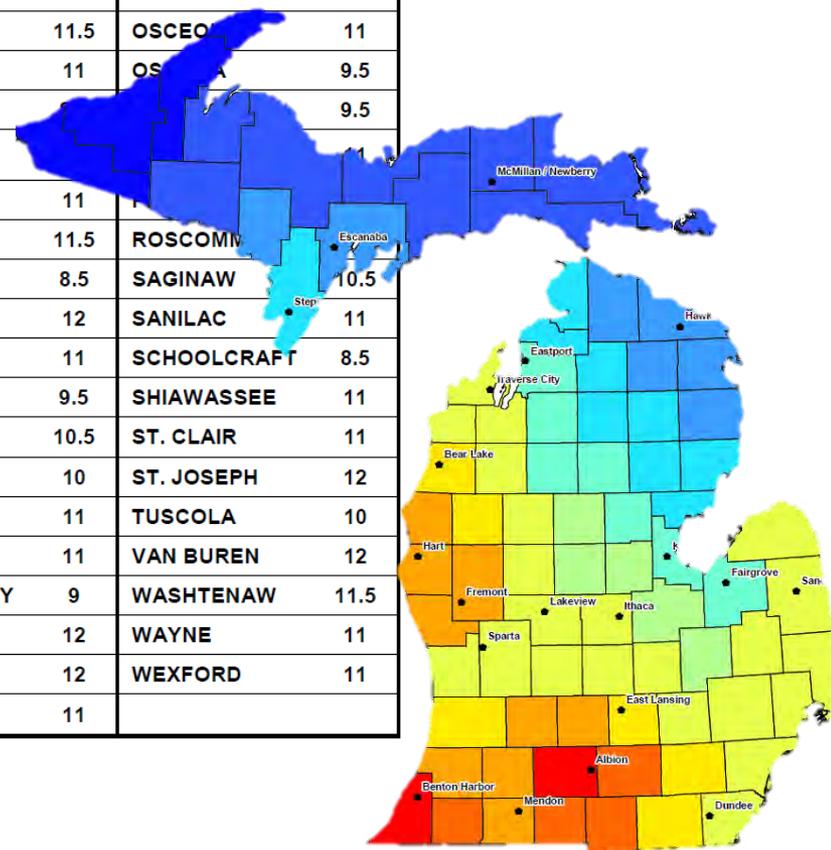
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	7/9/2015	49.3	49.3	%	9.4	°C	9.4	1013.2	49.3	°C
	7/9/2015	49.3	49.3	%	9.4	°C	9.4	1013.2	49.3	°C
	7/9/2015	49.3	49.3	%	9.4	°C	9.4	1013.2	49.3	°C
	7/9/2015	49.3	49.3	%	9.4	°C	9.4	1013.2	49.3	°C

County Specific Temperature

Table 3
Facility Specific Temperatures by County (degrees Celsius)

County	Temp	County	Temp	County	Temp	County	Temp
ALCONA	9	DICKINSON	9	LAKE	11.5	OCEANA	12
ALGER	8.5	EATON	12	LAPEER	11	GEMAW	9.5
ALLEGAN	11.5	EMMET	9.5	LEELANAU	11	ONTONAGON	8
ALPENA	9	GENESEE	10.5	LENAWEE	11.5	OSCEOLA	11
ANTRIM	10	GLADWIN	10	LIVINGSTON	11	OSHTON	9.5
ARENAC	9.5	GOGEBIC	8	LUCE	9.5		
BARAGA	8.5	GRAND TRAVERSE	11	MACKINAC	11		
BARRY	12	GRATIOT	11	MACOMB	11		
BAY	10	HILLSDALE	12.5	MANISTEE	11.5	ROSCOMBE	10.5
BENZIE	11	HOUGHTON	8	MARQUETTE	8.5	SAGINAW	11
BERRIEN	13	HURON	11	MASON	12	SANILAC	11
BRANCH	12.5	INGHAM	11.5	MECOSTA	11	SCHOOLCRAFT	8.5
CALHOUN	13	IONIA	11	MENOMINEE	9.5	SHIAWASSEE	11
CASS	12.5	IOSCO	9.5	MIDLAND	10.5	ST. CLAIR	11
CHARLEVOIX	9.5	IRON	8.5	MISSAUKEE	10	ST. JOSEPH	12
CHEBOYGAN	9	ISABELLA	10.5	MONROE	11	TUSCOLA	10
CHIPPEWA	8.5	JACKSON	12.5	MONTCALM	11	VAN BUREN	12
CLARE	10.5	KALAMAZOO	12	MONTMORENCY	9	WASHTENAW	11.5
CLINTON	11	KALKASKA	10	MUSKEGON	12	WAYNE	11
CRAWFORD	9.5	KENT	11	NEWAYGO	12	WEXFORD	11
DELTA	9	KEWEENAW	8	OAKLAND	11		



Rule 7 Summary



Rule 27

- Replaces GVIIC and SVIIC
- Volatilization to Indoor Air Screening Levels and Criteria
 - Incorporates Tiered Process
 - Volatilization to Indoor Air Pathway (VIAP)
 - Volatilization to Indoor Air Criteria (VIAC)
 - Soil, groundwater and vapor concentrations

Tiered Approach

Conceptual Site Model
(CSM)



VI Tier 1

Generic Screening Levels

VI Tier 2

Generic Unrestricted Criteria

VI Tier 3A

Generic Criterion

VI Tier 3B

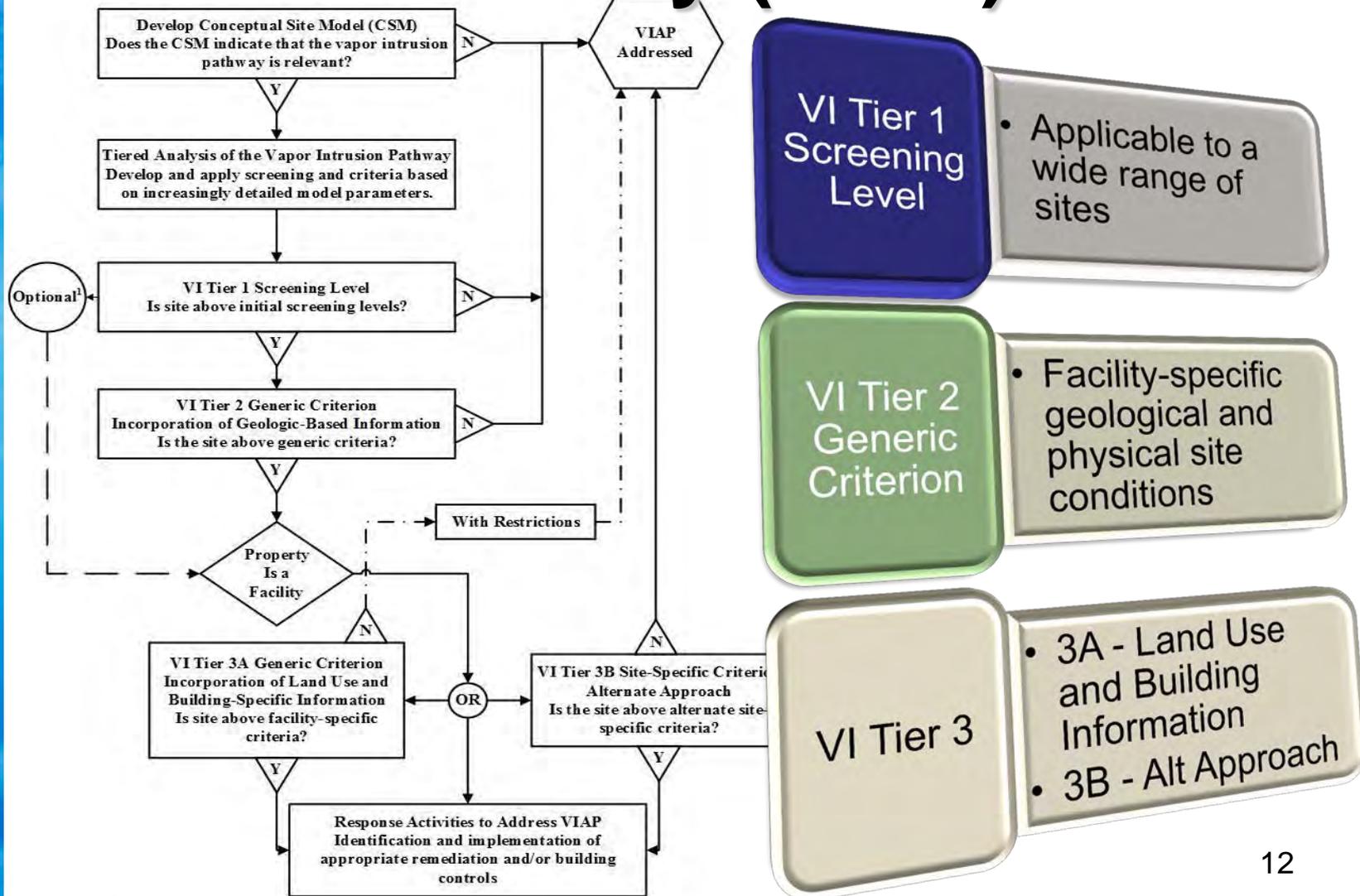
Site-Specific

Degree of Uncertainty

Additional Data

- Common in modern risk-based guidance
- Intended to promote:
 - Efficiency
 - Better characterization
- Other key features:
 - Self implemented
 - up to Tier 3a
 - Flexible

Volatilization to Indoor Air Pathway (VIAP)



Tiered Approach in Rules

- Process
 - more than just equations
 - combinations
- Generic criteria using facility specific inputs
 - No restrictions are necessary
 - Need to use the values provided
 - Previously allowed for. . . rarely used
 - Clear on when a party may elect to use

Generic Assumption #1

Residential Structure

0.11, 0.27, 0.71
Air Exchange Rate
0.25 hr⁻¹

49%, 45%
Area
100 m² or 1076 ft²
10m x 10m or 32.8 ft x 32.8 ft

Mixing Height
2.44m or 8ft

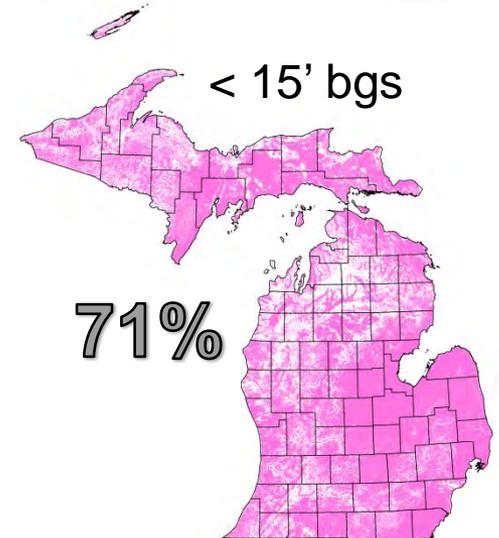
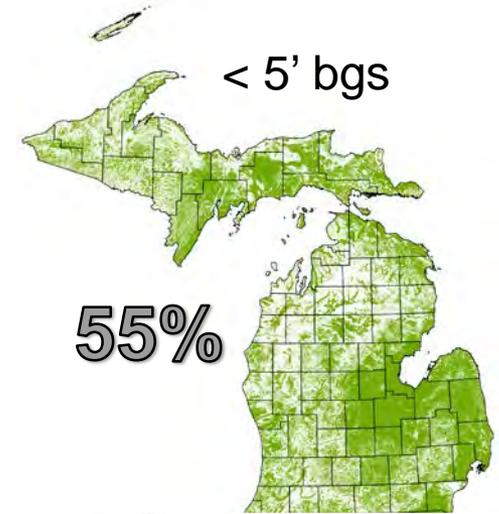
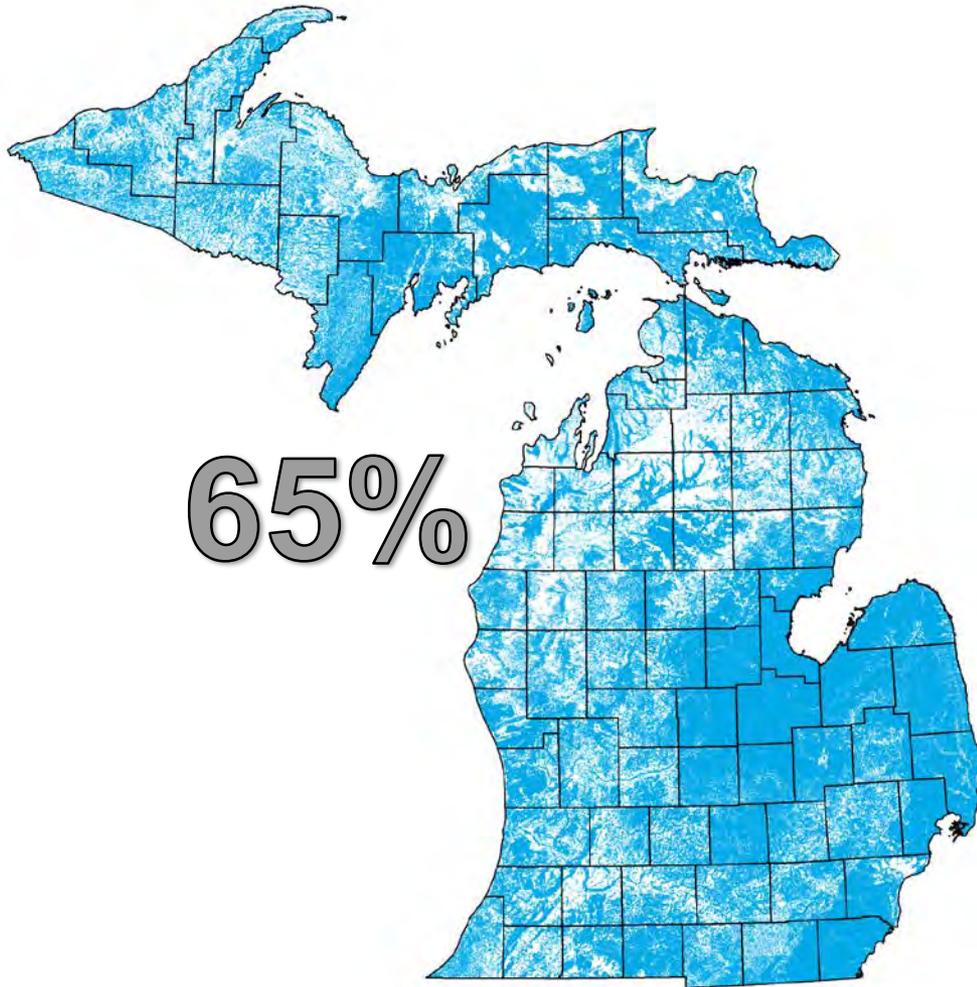
77%
Basement bgs
2m or 6.6ft

Groundwater
3m or 9.8ft

Utilities
1m or 3.3ft

Generic Assumption #2

Depth to GW < 10 feet



VI Tier I: Initial Screening

- Applicable to most sites
 - Soil, groundwater, and vapor
 - Designed to be protective for any VI
 - Identifies a potential “source of vapor”
 - Limited data necessary
- Determines whether any further investigation of the VI pathway is necessary

Tier I Outcomes

- A source of vapors is not present
 - No further investigation or response action required

OR

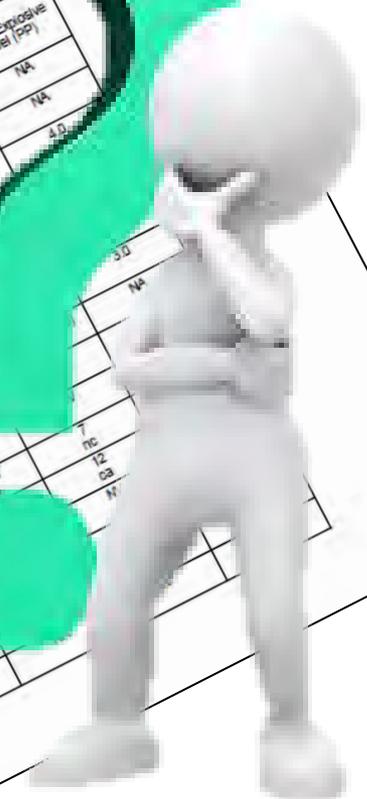
- A source of vapors may be present that poses the potential for VI
 - Parties may proceed to VI Tier 2, VI Tier 3A, or 3B; and/or
 - Implement a response action (remedy)
 - Party may use the values to establish a facility

VI Tier 1 Screening Values

TABLE 4. VI TIER 1 GROUNDWATER, SOIL AND VAPOR SCREENING LEVELS
PART 201 GENERIC SCREENING LEVELS/PART 213 RISK-BASED SCREENING LEVELS

The Tier 1 vapor intrusion screening levels serve as the basis for the development of Tier 2 generic residential and Tier 3A generic restricted categorical criteria. Tier 1 screening levels as the generic residential clean-up criteria. All soil and groundwater values, unless otherwise noted, are expressed in units of parts per million (ppm) or micrograms per liter (µg/L). One ppb is equivalent to 1 µg per liter (µg/L) for groundwater and 1 µg per liter (µg/L) for soil. A footnote is designated by one or more letters in parentheses and is defined in R 299.49(4). The abbreviation "nc" is used to denote a non-criterion. When the health-based value is less than the target detection limit (TDL), the TDL is listed as the criterion [MCL §324.20120a(10)]. In these cases, the first number is the criterion (i.e., TDL), and the second number is the health-based value.

Hazardous Substances	Chemical Abstract Service Number	Groundwater Values		Water Solubility		Flammability and Explosivity Screening Level	Soil Values		Soil Saturation Concentration Screening Levels		Lower Explosive Level (%)
		nc	ppm	ppm	ppm		ppm	ppm	ppm	ppm	
Acetone	63329	43	nc	3,300	NA	2.1E+05	NA	NA	7,350	nc	NA
Acetone (I)	209966	65	nc	16,000	NA	NA	2,800 (M); 34 (I)	NA	7,350	nc	NA
Acetone (II)	75070	100 (M); 4 (I)	NA	1.0E+09	1.1E+07	NA	NA	NA	310	nc	4.0
Acetaldehyde (I)	61197	59,600	nc	1.0E+09	1.0E+09	1.0E+09 (S)	6.0E+05	nc	3.5E+07		
Acetaldehyde (II)	67641	25,800	nc	1.0E+09	1.0E+09	1.0E+09 (S)	2.7E+05	nc	3.7E+07		
Acetic acid (OO)	75068	8,690 (OO)	del	1.0E+09	1.0E+09	1.7E+07	2,800 (M); 650 (I)	nc	4.2E+07		
Acetone (I)	98982	20 (M); 5.2E-03 (I)	del	1.0E+09	1.0E+09	1.4E+07	6.2E+05 (OO)	del	8.4E+07		
Acetone (II)	107028	15	nc	1.0E+09	1.0E+09	7.9E+07	250 (M); 4.6E+02 (I)	del	3.5E+07		
Acetonitrile	75061	15	nc	1.0E+09	1.0E+09	2.4E+05	NA	NA	250	nc	7
Acetophenone (OO)	79107	2 (M); 8.3E-02 (I)	del	1.0E+09	1.0E+09	6.0E+06	1.0E+09 (S)	del	100 (M); 1.2 (I)	del	12
Acrolein (I)	107131	15	nc	1.0E+09	1.0E+09	1.0E+07	NA	NA	NA	nc	7
Acrylamide (MM)	1597368	15	nc	1.0E+09	1.0E+09	1.0E+07	NA	NA	NA	nc	12
Acrylic acid (OO,OO)	116063	15	nc	1.0E+09	1.0E+09	1.0E+07	NA	NA	NA	nc	7
Acrylonitrile (I)	1645884	15	nc	1.0E+09	1.0E+09	1.0E+07	NA	NA	NA	nc	12
Acrylonitrile (II)	1546973	15	nc	1.0E+09	1.0E+09	1.0E+07	NA	NA	NA	nc	7



VI Tier 2: Generic Unrestricted Criteria

- “Facility” determination
- Identifies a source of vapors
 - Incorporates site-specific (geologic) information
 - Aids in identifying use limitations
- Land use or building information can not be modified
- Tier 1 may equal Tier 2

VI Tier 2 Outcomes

- Property is not a facility
 - A source of vapors is NOT present
- OR**
- Property is a facility
 - Proceed to Tier 3A or 3B to further evaluate vapor intrusion risks; or
 - Proceed to an appropriate response action



Calculator to Generate the
VI TIER 2
Volatilization to Indoor Air Criteria
(Tier 2 VIAC)

Clear Contents

PROJECT INFORMATION

NOTES:

What is the expected shallowest depth of groundwater?	<input type="text"/>	<i>Additional information is required</i>
Depth to groundwater:	<input type="text" value="Input Needed"/>	
How are your soils classified?	<input type="text"/>	<i>Additional information is required</i>
What is your soil type?	<input type="text"/>	
SCS soil textural classification code:	<input type="text" value="Input Needed"/>	
Temperature utilized for TS:	<input type="text" value="Input Needed °C"/>	
System temp based upon:	<input type="text" value="Kent"/>	

Soil type impacts. . .

Dry Bulk Density	Air-Filled Porosity	Effective Total Fluid Saturation	Relative Air Permeability	Total porosity in capillary zone	Effective Vapor Permeability
Soil total porosity	Residual soil water content	vadose zone soil intrinsic permeability	Cap zone eff diffusion coefficient	Building Separation (including cap fringe)	Water filled porosity in capillary zone
Soil water-filled porosity	Soil saturated hydraulic conductivity	Thickness of capillary zone	Total overall effective diffusion coefficient	Crack effective diffusion coefficient	Infinite source bldg. conc.
van Genuchten shape parameter	Mean particle diameter	Peclet number	attenuation coefficient	Stratum effective diffusion coefficient	Average vapor flow rate into bldg.
	Indoor exp groundwater conc			Air filled porosity in capillary zone	



Calculator to Generate the
VI TIER 2
 Volatilization to Indoor Air Criteria
 (Tier 2 VIAC)

Clear Contents

2 +/- PROJECT INFORMATION

NOTES:

What is the expected shallowest depth of groundwater?

Depth to groundwater:

11 ft
 335 cm

Depth to groundwater value must be verified and documented as it assumes it is not in contact with a structure

How are your soils classified?

What is your soil type?

SCS soil texture classification code:

Temperature utilized for I_{soil}:

System temp based upon:

Confirmed via lab analysis
 loam
 L
 11.0 °C
 Kent

Supporting documentation must be able to identify the site soils

11

26 +/-

83

	VI Tier 1			VI Tier 2		
	VI Tier 1 Soil	VI Tier 1 Groundwater	VI Tier 1 Vapor	VI Tier 2 Soil	VI Tier 2 Groundwater	VI Tier 2 Vapor
Benzene (I, KK)	50 (M); 1.7 tdl	1 (M); 0.13 tdl	110 ca	120 ca	540 ca	110 ca
Tetrachloroethylene (KK)	50 (M); 6.4 tdl	1.6 nc	1,400 nc	440 nc	2,900 nc	1,400 nc
Trichloroethylene (DD, KK, MM, NN)	50 (M); 0.33 tdl	1.0 (M); 7.3E-02 tdl	67 (DD) dev	50 (M); 25 tdl	210 (DD) dev	67 (DD) dev



VI Tier 3

2 Tiers

- VI Tier 3A – Generic Criterion
 - Self implementing
 - Uses established values and inputs and allows:
 - Incorporates the use of land use or building information, or both
 - Requires a land or resource use restriction
- VI Tier 3B – Site-Specific
 - Department approval
 - Site specific data (NOT other book data)
 - May use an alternate model

VI Tier 3A

Land Use and Building Info

- Identifies potential for VI
- All of Tier 2 **PLUS**:
 - Land use (res and nonres use)
 - Building parameters
- IDs whether remediation, mitigation or building/use restrictions are warranted
- Self implement

VI Tier 3A Outcomes

- Property is a facility
 - A source of vapors is present but doesn't pose a risk for VI

OR

- Property is a facility
 - A source of vapors is present that may pose an unacceptable risk



Calculator to Generate the
VI TIER 3A
Volatilization to Indoor Air Criteria
(Tier 3A VIAC)

Clear Contents

PROJECT INFORMATION

Residential or nonresidential exposure?

Building type?

Foundation type?

FOR INFORMATION PUPOSES ONLY:

Indoor air exchange rate (ER):	Info Needed	hr ⁻¹	Enclosed space floor length (L _a):	Info Needed	m
Enclosed space floor thickness (L _{crack}):	Info Needed	cm	Enclosed space floor width (W _a):	Info Needed	m
Distance below grade to bottom of enclosed space floor (L _F):	Info Needed	cm	Enclosed space height (H _a):	Info Needed	m

Notes:

What is the expected shallowest depth of groundwater? Additional information is required

Depth to groundwater: Input Needed

How are your soils classified?

What is your soil type?

SCS soil textural classification code: Input Needed Additional information is required

Temperature utilized for TS: Input Needed °C

System temp based upon: Kent





Calculator to Generate the
VI TIER 3A
Volatilization to Indoor Air Criteria
(Tier 3A VIAC)

Clear Contents

PROJECT INFORMATION

Residential or nonresidential exposure?

Nonresidential
Manufacturing
Basement

2 +/-

Building type?

Foundation type?

FOR INFORMATION PUROSES ONLY:

Indoor air exchange rate (ER):	1.50	hr ⁻¹	Enclosed space floor length (L _B)	20	m
Enclosed space floor length (L _{crack})	15	cm	Enclosed space floor width (W _B)	20	m
Distance below grade to bottom of floor (D _{fg})	200	cm	Enclosed space height (H _B)	3.66	m

2 +/-

Notes:

What is the expected shallowest depth of groundwater?

11 ft
335 cm

Groundwater value must be verified and documented as it assumes it is not in contact with a structure

11

Depth to groundwater:

How are your soils classified?

Confirmed via lab analysis
loam
L
11.0 °C
Kent

26 +/-

Supporting documentation should be able to identify the site soils as a loam.

SCS soil textural classification code:

Temperature utilized for TSA:

System temp based upon:

83



Tiered Analysis

- Assumptions:
 - Manufacturing with a basement
 - 11 feet to GW
 - Located in Kent County
 - USDA Classification: Loam

	VI Tier 1			VI Tier 2			VI Tier 3A			
	VI Tier 1 Soil	VI Tier 1 Groundwater	VI Tier 1 Vapor	VI Tier 2 Soil	VI Tier 2 Groundwater	VI Tier 2 Vapor	VI Tier 3A Soil	VI Tier 3A Groundwater	VI Tier 3A Vapor	VI Tier 3A Vapor 1M
Benzene (I,KK)	50 (M); 1.7 tdl	1 (M); 0.13 tdl	110 ca	120 ca	540 ca	110 ca	3,900 ca	3,100 ca	260 ca	5.9E+05 ca
Tetrachloroethylene (KK)	50 (M); 6.4 tdl	1.6 nc	1,400 nc	440 nc	2,900 nc	1,400 nc	9,100 nc	18,000 nc	2,040 nc	4.8E+06 nc
Trichloroethylene (DD,KK,MM,NN)	50 (M); 0.33 tdl	1.0 (M); 7.3E-02 tdl	67 (DD) dev	50 (M); 25 tdl	210 (DD) dev	67 (DD) dev	360 (DD) dev	1,200 (DD) dev	67 (DD) dev	1.6E+05 (DD) dev

VI Tier 3B

Site Specific

- May use
 - Same model as the DEQ but site-specific information
 - Different models
 - NAPL
 - Multi-layered
 - Petroleum
- DEQ approval
- Outcomes. . .
 - Facility(?)
 - Unacceptable risk

Rule 7 Questions?

