Tuesday May 12, 2020
Medway Planning and Economic Development Board
155 Village Street
Medway, MA 02053

REMOTE MEETING

Members	Andy Rodenhiser	Bob Tucker	Tom Gay	Matt Hayes	Rich Di Iulio	Jessica Chabot
Attendance	X	X	X	X	X	X

Pursuant to Governor Baker's March 12, 2020 Order Suspending Certain Provisions of the Open Meeting Law, and the Governor's March 15, 2020 Order imposing strict limitations on the number of people that may gather in one place, no in-person attendance of members of the public will be permitted at this meeting. Members of the public who wish to watch the meeting may do so, on Medway Cable Access: channel 11 on Comcast Cable, or channel 35 on Verizon Cable; or on Medway Cable's Facebook page @medwaycable.

ALSO PRESENT IN ZOOM MEETING:

- Susy Affleck-Childs, Planning and Economic Development Coordinator
- Amy Sutherland Recording Secretary
- Gino Carlucci, PGC Associates
- Steve Bouley, Tetra Tech

The Chairman opened the meeting at 7:01 pm and read the above noted announcement.

There were no Citizen Comments.

ANR Plan for 62 Adams Street:

The Board is in receipt of the following: (**See Attached**)

- ANR application for Jim and Shelley Wieler
- Gino Carlucci review letter dated May 6, 2020
- ANR plan dated May 7, 2020 by O'Driscoll Land Surveying as revised per review comments

Property owners Jim and Shelley Wieler participated in the ZOOM meeting. Consultant Carlucci reviewed the ANR plan. The property will be split into two lots, each compliant with zoning requirements for adequate frontage (on Adams Street), area, and uplands. One lot will contain the existing house; the other lot will be available for new construction. There were a couple of minor deficiencies in the original plan which have been corrected. It is Mr. Carlucci's recommendation that the Board endorse the revised ANR plan for 62 Adams Street, dated May 7, 2020.

On a motion made by Bob Tucker and seconded by Rich Di Iulio, the Board voted by Roll Call to endorse the ANR Plan dated May 7, 2020 for 62 Adams Street as presented.

Roll Call Vote:

Rich Di Iulio	**aye**
Bob Tucker	**aye**
Tom Gay	**aye**
Andy Rodenhiser	**aye**
Matt Hayes	**aye**

Signatory:
On a motion made by Bob Tucker and seconded by Matt Hayes, the Board voted by Roll Call to have Member Gay be the signatory on the plan on behalf of the Board.

Roll Call Vote:

Rich Di Iulio	**aye**
Bob Tucker	**aye**
Tom Gay	**aye**
Andy Rodenhiser	**aye**
Matt Hayes	**aye**

CHOATE TRAIL SUBDIVISION – Public Hearing Continuation:

The Board is in receipt of the following: (**See Attached**)

- Public Hearing continuation notice
- Connorstone Engineering letter dated 3-9-20 with revised plan.
- Revised subdivision plan dated 3-9-20
- Tetra Tech review letter dated 3-26-20 on revised plan
- PGC review letter dated 3-31-20 on revised plan
- Existing Conditions sheet with large trees noted (received 4-3-20)
- Email dated 4-7-20 from abutter Amy Jordan
- Tax status certification from Medway Treasurer dated 4-6-20
- 4-28-20 email from Connorstone Engineer Vito Colonna with comments on draft decision
- Revised draft decision dated 5-5-20
- Email from abutter Amy Jordan dated 5-11-2020

The following were present during the zoom meeting:

- Vito Colonna, P.E. Connorstone Engineering
- Bob Pace, Residences at Choate Trail, LLC
- Matthew Silverstein, Residences at Choate Trail, LLC

The Board and applicant have a copy of the draft decision. The applicant is also in receipt of the review letters from Tetra Tech and PGC Associates. Those comments and suggestions were incorporated into the draft decision. There was an email from abutter Amy Jordan dated April 7, 2020.

<u>Abutter, 40 Highland Street, Amy Jordan:</u>
Ms. Jordan was present during the ZOOM meeting. She wanted to know what the policy is for blasting since her home is next to the development. She also asked about deer resistant plantings. She thought a simple fencing on a proposed pathway is an option instead of fencing. There is a concern about what happens if the border trees happen to fall on the new road, who is responsible.

She finally wanted to know when the project begins if a COVID-19 plan would be shared with the residents.

It was explained that if there is a need for blasting, it must be done in conjunction with a blasting plan and permit from the Medway Fire Department.

Applicant Bob Pace agreed to look to see if there are deer resistant shrubs. There will also be a COVID-19 plan which will be put in place to ensure safety for those working on site.

Abutter, Linda Bannon 38 Highland Ave:
Ms. Bannon is also concerned about the deer who will likely eat the rhododendron bushes proposed. She would like to see another type of plant which is not eaten by the deer. She also wanted clarity about the easement and the trail.

The easement will be to allow public access along a trail on Lot #4. It was recommended to put language in the decision that the access will be for pedestrian access only. The width of the easement is 15 ft. The sidewalk will be on the southern side of the road, Copper Drive, over which the easement will run until it gets to Lot #4.

Consultant Carlucci informed the Board that all the comments from his review have been addressed. There are no outstanding issues. Consultant Bouley indicted that all of his comments were also addressed except for the street lighting pole and wires going underground.

The Board agreed that it is in the best interest for the electrical line to go across Highland Street to the new pole on the north side and then underground within the development.

The following was noted:

- The stormwater management plan does not need a separate parcel.
- List of final edits need to be on plan with noted dates.
- Get a recommendation from Sergeant Watson about where he wants the streetlight (pole 33 or the new pole adjacent to the subdivision?).
- Put in language about replacement of shrubbery or shielding for deer.
- There was language included for tree preservation about replacement of removed trees and/or contributions to the tree fund. The Board agreed to reduce the number of trees that would have to be replaced by 5%.
- There is a reference of the Order of Conditions from the Conservation Commission.

Waivers:
On a motion made by Bob Tucker and seconded by Rich Di Iulio, the Board voted by Roll Call to approve the waivers as presented.

Roll Call Vote:

Rich Di Iulio	**aye**
Bob Tucker	**aye**
Tom Gay	**aye**
Andy Rodenhiser	**aye**
Matt Hayes	**aye**

Evaluation Criteria:
On a motion made by Bob Tucker and seconded by Rich Di Iulio, the Board voted by Roll Call to approve the evaluation criteria.

Roll Call Vote:

Rich Di Iulio	**aye**
Bob Tucker	**aye**
Tom Gay	**aye**
Andy Rodenhiser	**aye**
Matt Hayes	**aye**

Decision:
On a motion made by Bob Tucker and seconded by Matt Hayes, the Board voted by Roll Call to approve the decision as edited from the discussion.

Roll Call Vote:

Rich Di Iulio	**aye**
Bob Tucker	**aye**
Tom Gay	**aye**
Andy Rodenhiser	**aye**
Matt Hayes	**aye**

Closing Hearing:
On a motion made by Rich Di Iulio and seconded by Matt Hayes, the Board voted by Roll Call to close the public hearing.

Roll Call Vote:

Rich Di Iulio	**aye**
Bob Tucker	**aye**
Tom Gay	**aye**
Andy Rodenhiser	**aye**
Matt Hayes	**aye**

Signing of Decision:
On a motion made by Rich Di Iulio and seconded by Matt Hayes, the Board voted by Roll Call to authorize Tom Gay to sign the decision on behalf of the Board.

Roll Call Vote:

Rich Di Iulio	**aye**
Bob Tucker	**aye**
Tom Gay	**aye**
Andy Rodenhiser	**aye**
Matt Hayes	**aye**

Medway Mill Site Plan & Medway Place Site Plan:
The Chairman announced that the hearings for the Medway Mill Site Plan and Medway Place Shopping Plaza Site Plan will be continued to May 26, 2020.

CONSTRUCTION REPORTS:

The Board is in receipt of the following reports from Tetra Tech: (**See Attached**)

- William Wallace Village CO Report #4 and #5 from March 19 and March 25, 2020.
- Salmon ARCPUD CO reports #28-36 from November 12, 2019 through April 27, 2020.

William Wallace:

The excavation for the footings appears to have been completed. The site is stabilized with crushed stone material. The erosion controls appear to be in good condition. Construction has halted due to the Covid-19 emergency.

Salmon:

The site is coming along nicely. Vegetation continues developing along the slopes and the bottom of Basin 1 and Basin 3. The Rip Rap remains in good condition at each basin's forebay. There will be monitoring of the infiltration basins.

Millstone Village:

The Board is in receipt of an email dated May 12, 2020 from Millstone resident Ray Bigelow regarding Millstone. (**See Attached**) It is his understanding that there are shrubs and trees shown on the landscape plan which have not be installed. The Board communicated that this landscaping plan will be reviewed and checked before any funds are released. The Board would like there to be follow-up with Mr. Venincasa about this matter. Susy Affleck-Childs will send him an email.

ZONING BOARD OF APPEALS PETITION:

The Board is in receipt of the following: (**See Attached**)

- Accessory family dwelling unit special permit application for 18 Broad Acres Farm Road.

The Board reviewed the application for a special permit application for 18 Broad Acres Farm Road. This is for a free standing AFDU of 880 sq. ft. plus garage. The hearing for this application is for June 3, 2020. It was noted that this is the first AFDU application for a free-standing dwelling unit. The Board has no comments or objections to this application.

PEDB MEETING MINUTES:

April 28, 2020:

On a motion made by Rich Di Iulio and seconded by Tom Gay, the Board voted by Roll Call to approve the minutes from April 28, 2020 and March 5, 2020 with the amended recommendations.

Roll Call Vote:

Rich Di Iulio	**aye**
Bob Tucker	**aye**
Tom Gay	**aye**
Andy Rodenhiser	**aye**
Matt Hayes	**aye**

HILLVIEW ESTATES:

The Board is in receipt of the following: (**See Attached**)

- Letter from property owner Christine Price dated May 12, 2020.

NOTE – On the ZOOM meeting were Christine Price, her local representative Tony Biocchi, and buyer Sean Smith.

The Board was made aware that some unauthorized site work was being done on the property. This work was discovered when Tony Biocchi and David Travalini, Chairman of the Conservation Commission, were on site May 8, 2020 while reviewing the site for the building permit application. The work done involved digging portions of the roadway along with land clearing outside the limit of work. The Board was made aware that the purchase and sale agreement with Mr. Smith will not be happening. Ms. Price will be continuing to seek a possible buyer. There is another site walk scheduled for tomorrow so that Conservation Agent Bridget Graziano can view the scope of land disturbance.

AMENDMENTS TO ENVIRONMENTAL STANDARDS section of the Zoning Bylaw

The Board is in receipt of the following: (**See Attached**)

- Email from John Lally dated May 11, 2020
- Email letter and draft edits from odor consultant Bruce Straughan dated May 11, 2020
- Email from Caroline Wells dated May 12, 2020 with revised draft
- Email from John Lally dated May 12, 2020 re: revised draft

The Board was provided with the most recent draft of the environmental standards dated May 12th. It incorporates comments from odor consultant Bruce Straughan and noise consultant Jeff Komrower and edits offered by Barbara Saint Andre. Susy Affleck-Childs reported there are no funds left for any further consulting services since the special appropriation of funds was used up along with some of the Board's FY20 consulting services budget.

John Lally of 35 Coffee Street was present on the ZOOM meeting and expressed the following comments:

- When referring to the odor threshold, the industry term is "detection" threshold, not "detectable". It is his strong recommendation to use an **undiluted** odor detection threshold. The draft should be revised to reflect such. He cannot support it otherwise at town meeting.
- The draft includes odor applicability qualifiers (continuous, frequent or repetitive). Use of those qualifiers risks exposing Medway residents to episodic odors that don't meet those standards. Those qualifiers could be deleted. However, it might be wise to exempt odors resulting from infrequent repairs and maintenance of septic and sewer systems.
- The bylaw should protect Medway residents from mixtures of odorants which have potential to cause odor intensities much greater than the intensities caused by odorants in isolation.
- The odor bylaw should leave the technical details of odor compliance and enforcement to those professionals with that expert knowledge and who are trained. The cost of the compliance should be borne by the applicants and the costs of enforcement by the violators.

There continues to be the question about how we measure odor. There needs to be some measure of validation since it is too subjective. There was considerable discussion about the use of the Nasal Ranger which uses a dilution of odor technique. Board members agreed that the dilution of odor technique does not provide a suitable measurement. There needs to be a statement which defines the threshold so the Building Commissioner can make a suitable determination. The language regarding

Building Commissioner and Zoning Enforcement Officer needs to be consistent throughout the document.

Consultant Carlucci will work on language with Susy to present to the Board.

OTHER BUSINESS:

- The Board of Selectmen will be considering a new 3-year contract with Tetra Tech for on-call engineering consulting services.
- Susy Affleck-Childs is continuing to work on the final edits for the Open Space and Recreation Plan.
- Andy Rodenhiser reported that a task force is being created to assist in getting restaurants up and running throughout town (outside dining, possibly changes to parking areas, etc.)

FUTURE MEETING:

- Tuesday, May 26, 2020

ADJOURN:

On a motion made by Rich Di Iulio and seconded by Matt Hayes, the Board voted by Roll Call vote to adjourn the meeting.

Roll Call Vote:

Rich Di Iulio	**aye**
Bob Tucker	**aye**
Tom Gay	**aye**
Andy Rodenhiser	**aye**
Matt Hayes	**aye**

The meeting was adjourned at 10:01 pm.

Prepared by,
Amy Sutherland
Recording Secretary

Reviewed and edited by,
Susan E. Affleck-Childs
Planning and Economic Development Coordinator

May 12, 2020

Medway Planning & Economic Development Board Meeting

ANR Plan for 62 Adams Street

- ANR application from Jim and Shelley Wieler
- Gino Carlucci's review letter dated May 6, 2020
- ANR plan dated May 7, 2020 by O'Driscoll Land Surveying as revised per review comments

O'DRISCOLL LAND SURVEYING, Inc.
46 Cottage Street
Medway, Massachusetts, 02053
Phone: 508-533-3314
Email: odlandsurvey@gmail.com

Town of Medway Planning Board
Town Hall
Village Street
Medway, MA

April 30, 2020

RE: 62 Adams Street ANR Plan

Medway Planning board

This letter is meant to act as written evidence that the plan submitted by this office dated April 26, 2020, on behalf of James & Shelley Wieler, meets the requirements for endorsement under Chapter 81-P.

Both lots shown have frontage on Adams Street, a public way.

Both lots conform to the required frontage, area, lot shape factor, and contiguous upland area required in the zoning by-laws for the AR-I zoning district.

Please feel free to contact me if you have any questions.

Daniel A. O'Driscoll

Daniel A. O'Driscoll
Professional Land Surveyor
Certified Soil Evaluator

Planning & Economic Development Board - Town of Medway, MA

LAND SUBDIVISION – FORM A

Application for Endorsement of Plan Believed Not to Require Subdivision Approval (ANR)

INSTRUCTIONS TO APPLICANT/OWNER

This Application is made pursuant to the Medway *Subdivision Rules and Regulations*.
Please complete this entire Application.

Submit two (2) signed originals of this ANR Application, two copies of the ANR Plan, an electronic version (PDF) of the ANR plan, two Project Explanations, and the appropriate ANR application/filing fee checks to the Medway Planning and Economic Development office, 155 Village ST, Medway, MA 02053.

The Applicant certifies that the information included in this Application is a true, complete and accurate representation of the facts regarding the property under consideration.

In submitting this application, the Applicant and Property Owner authorize the Planning & Economic Development Board and its agents to access the site during the plan review process.

The Town's Planning Consultant will review the Application, Project Explanation and ANR plan and provide a recommendation to the Planning & Economic Development Board.
A copy of that letter will be provided to you. Revisions to the plan may be needed.

You or your duly authorized agent is expected to attend the Board meeting when the ANR Plan will be considered to answer any questions and/or submit such additional information as the Board may request.
Your absence may result in a delay in the Board's review and decision.

_______________________, 20____

TO: *The Planning & Economic Development Board of the Town of Medway, MA*

The undersigned, wishing to record the accompanying plan of property in the Town of Medway and believing that the plan does not constitute a subdivision within the meaning of the Subdivision Control Law, herewith submits this Application and ANR Plan to the Medway Planning and Economic Development Board and requests its determination and endorsement that the Board's approval under the Subdivision Control Law is not required.

PROPERTY INFORMATION

ANR Location Address(es): 62 Adams St

The land shown on the plan is shown on Medway Assessor's Map # 28 Parcel(s) # 015

Total Acreage of Land to be Divided: 4.63 acres

Subdivision Name (if applicable): ____________

Medway Zoning District Classification: AR-1

Is the road on which this property has its frontage a designated ***Medway Scenic Road***? yes

The owner's title to the land that is the subject matter of this application is derived under deed from: James G & Shelley W Wieler to Wieler Living Trust dated 11/1/2012 and recorded in Norfolk County Registry of Deeds, Book 30631 Page 302 or Land Court Certificate of Title Number ________, Land Court Case Number ___________, registered in the Norfolk County Land Registry District Volume __________, Page ___________.

ANR PLAN INFORMATION

Plan Title: FLAN OF LAND IN MEDWAY MASSACHUSETTS

Prepared by: O'DRISCOLL LAND SURVEYING, INC, DANIEL A. O'DRISCOLL

P.E. or P.L.S registration #: PLS 39050 Plan Date: APRIL 29, 2020

APPLICANT INFORMATION

Applicant's Name: (SAME AS OWNER)

Address:

Telephone: Email:

PROPERTY OWNER INFORMATION

(If different than the applicant or if the plan shows a land swap between two adjacent properties)

Property Owner's Name: James G & Shelley W Wieler, Trustees Wieler Living Trust

Address: 62 Adams St
Medway MA 02053

Telephone: 508-254-2955 Email: shelleywieler@gmail.com

ENGINEER or SURVEYOR INFORMATION

Name: DANIEL A. O'DRISCOLL

Address: 46 COTTAGE ST. MEDWAY MA

Telephone: 508-533-3314 Email: odlandsurvey@gmail.com

ATTORNEY INFORMATION

Name:

Address:

OFFICIAL REPRESENTATIVE INFORMATION

Name: DANIEL A. O'DRISCOLL

Address: 46 COTTAGE ST. MEDWAY MA

Telephone: 508 533 3314 Email: odlandsurvey@gmail.com

PROJECT EXPLANATION

Provide a cover letter with a detailed explanation of how you propose to divide the land, what land transaction will occur, and what land reconfiguration will result from the endorsement and recording of this ANR Plan.

APPROVAL NOT REQUIRED JUSTIFICATION

The Applicant believes that the Board's approval under the Subdivision Control Law is not required for the following reasons: *(Check all that apply.)*

_____ 1. The accompanying plan does not show a division of land.

X 2. Every lot shown on the plan has frontage as required by the Medway Zoning Bylaw. The frontage required by the Zoning Bylaw is located on ADAMS ST. *(name of way(s)*, which is:

X a. A public way. Date of street acceptance: ?

_____ b. A way certified by the Town Clerk as being maintained and used as a public way. *(Attach Town Clerk's certification)*

_____ c. A way shown on a definitive subdivision plan entitled _____________ that was previously endorsed by the Planning and Economic Development Board on _____________ and recorded at the Norfolk County Registry of Deeds on _____________ Provide detailed recording information: _____________

_____ d. A private way in existence on the ground before 1952 when the Subdivision Control Law was adopted in the Town of Medway, which has, in the opinion of the Planning & Economic Development Board, adequate width, suitable grades, and adequate construction to provide vehicular access to the lot(s) for their intended purpose of _____________ and to permit the installation of municipal services to serve the lot(s) and any buildings thereon.

_____ 3. The division of land shown on the accompanying plan is not a *"subdivision"* for the following reasons: _____________

SIGNATURES

The undersigned, being the Applicant as defined under Chapter 41, Section 81P for endorsement of an Approval Not Required Plan, herewith submits this application and Approval Not Required Plan to the Medway Planning and Economic Development Board for review and endorsement.

I hereby certify, under the pains and penalties of perjury, that the information contained in this application is a true, complete and accurate representation of the facts regarding the property under consideration.

(If applicable, I hereby authorize Dan O'Driscoll *to serve as my Agent/Official Representative to represent my interests before the Medway Planning & Economic Development Board with respect to this Approval Not Required Application.)*

In submitting this application, I authorize the Board, its consultants and agents, and Town staff to access the site during the plan review process.

_______________________________ 4/30/2020
Signature of Property Owner *Date*

_______________________________ _______________
Signature of Applicant (if other than Property Owner) *Date*

David A. O'Driscoll 4/30/2020
Signature of Agent/Official Representative *Date*

ANR PLAN FILING FEE

$250 plus $100 per lot or parcel for a plan involving three (3) or more lots/parcels, not to exceed a maximum of $750.

Please prepare two checks: one for $100 and one for the balance.
Each check should be made payable to: Town of Medway

Fee approved 11-2-06

APPLICATION CHECKLIST – All items must be submitted

- ______ *2 signed original ANR applications (FORM A)*
- ______ *2 full size prints of ANR plan*
- ______ *Electronic version of ANR plan – A flash drive may be provided or a PDF of the plan may be emailed to: planningboard@townofmedway.org.*
- ______ *2 copies of the Project Explanation*
- ______ *Application/Filing Fee (2 checks) – Check with PEDB office for amounts.*

****

ANR Application/Filing Fee Paid:

Amount: ____________ *Check #* ________________

Amount: ____________ *Check #* ________________

PGC ASSOCIATES, LLC.
1 Toni Lane
Franklin, MA 02038-2648
508.533.8106
gino@pgcassociates.com

MEMO TO: Medway Planning and Economic Development Board

FROM: Gino D. Carlucci, Jr.

DATE: May 6, 2020

RE: 62 Adams Street

I have reviewed the ANR plan submitted for endorsement by James and Shelley Wieler. The plan was prepared by O'Driscoll Land Surveying, Inc. of Medway, and is dated April 29, 2020. This plan divides a 4.63-acre lot into two lots of 2.06 acres and 2.57 acres.

I have comments as follows:

1. Section 3.2.4 of the subdivision regulations requires that the distance from a new lot line to any existing building/structure be indicated. This was not done, though it is clear that such distance exceeds the minimum side setback requirement.

2. Section 6.2 D. of the Zoning Bylaw requires that buildable lots include a contiguous area of uplands equal to or greater than 50% of the minimum area requirement of the zoning district. The plan shows uplands of 39,074 square feet, well in excess of the 22,000 square feet that is 50% of the minimum requirement. However, the uplands are not contiguous. The portion of uplands with frontage on the street appears to be more than half of the total so it should comply. This is not a requirement for ANR endorsement, but I recommend that the plan document that the contiguous uplands requirement is met.

With the minor change(s) noted above, I recommend that the plan be endorsed by the Board.

APROVAL UNDER THE SUBDIVISION CONTROL
LAW NOT REQUIRED

TOWN OF MEDWAY PLANNING BOARD

____

____

____

____

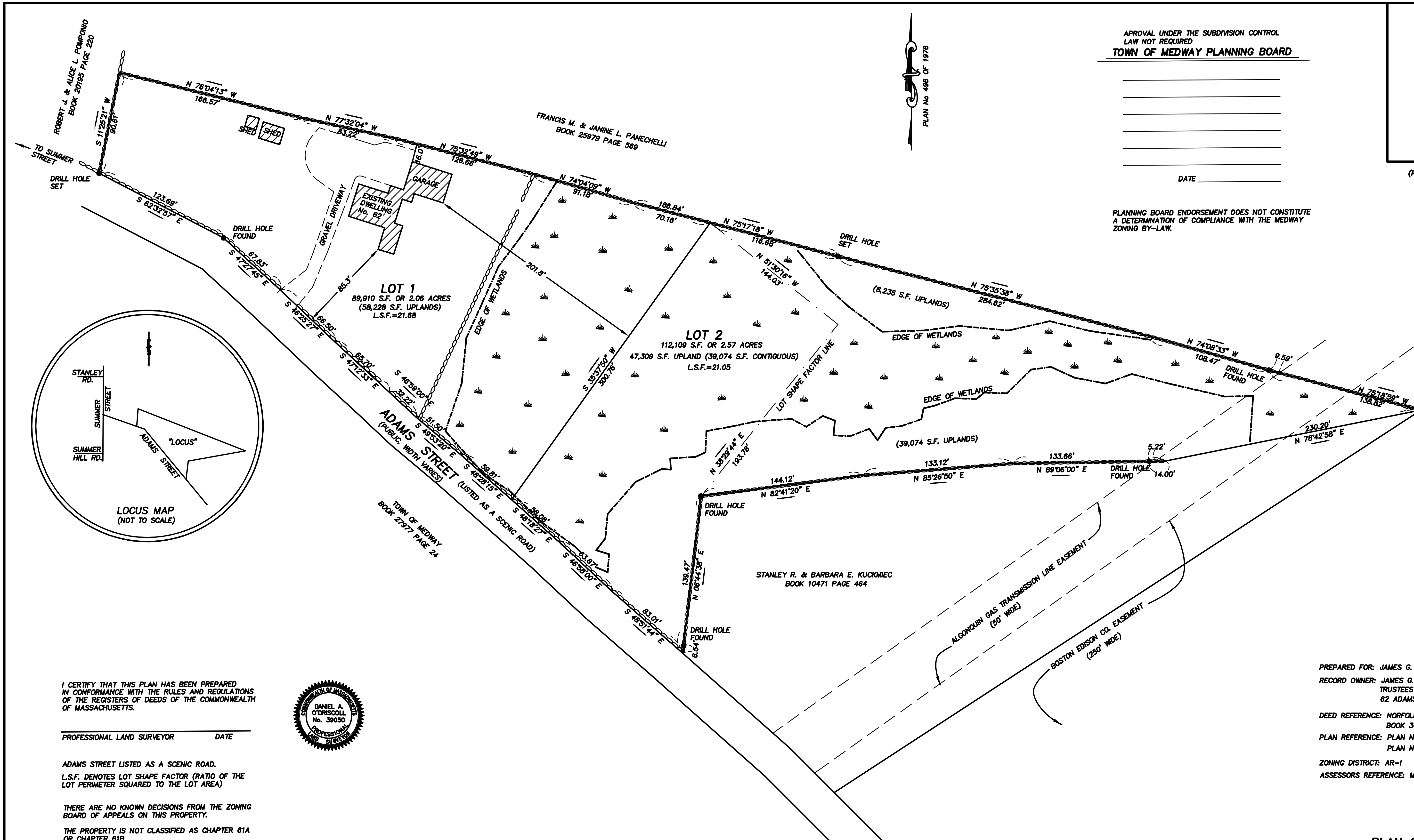
____

____

DATE ________________

(RESERVED FOR REGISTRY USE)

PLANNING BOARD ENDORSEMENT DOES NOT CONSTITUTE
A DETERMINATION OF COMPLIANCE WITH THE MEDWAY
ZONING BY-LAW.



I CERTIFY THAT THIS PLAN HAS BEEN PREPARED IN CONFORMANCE WITH THE RULES AND REGULATIONS OF THE REGISTERS OF DEEDS OF THE COMMONWEALTH OF MASSACHUSETTS.

____

PROFESSIONAL LAND SURVEYOR DATE

COMMONWEALTH OF MASSACHUSETTS
DANIEL A. O'DRISCOLL
No. 39050
PROFESSIONAL LAND SURVEYOR

ADAMS STREET LISTED AS A SCENIC ROAD.

L.S.F. DENOTES LOT SHAPE FACTOR (RATIO OF THE LOT PERIMETER SQUARED TO THE LOT AREA)

THERE ARE NO KNOWN DECISIONS FROM THE ZONING BOARD OF APPEALS ON THIS PROPERTY.

THE PROPERTY IS NOT CLASSIFIED AS CHAPTER 61A OR CHAPTER 61B.

ZONING DIMENSIONAL REQUIREMENTS
FOR AR I ZONING DISTRICT:

- MINIMUM AREA: 44,000 S.F.
- MINIMUM FRONTAGE: 180'
- MINIMUM FRONT SETBACK: 35'
- MINIMUM SIDE SETBACK: 15'
- MINIMUM REAR SETBACK: 15'

40' 0' 20' 40' 80' 160'

GRAPHIC SCALE

PREPARED FOR: JAMES G. WELER

RECORD OWNER: JAMES G. WELER & SHELLEY W. WELER
TRUSTEES OF WELER FAMILY FUNDING TRUST
62 ADAMS STREET MEDWAY, MA 02053

DEED REFERENCE: NORFOLK COUNTY REGISTRY OF DEEDS
BOOK 30631 PAGE 302

PLAN REFERENCE: PLAN No. 496 OF 1976
PLAN No. 474 OF 1990

ZONING DISTRICT: AR-I

ASSESSORS REFERENCE: MAP 28 PARCEL 015

PLAN OF LAND
IN
MEDWAY, MASSACHUSETTS

SCALE: 1"=40'

DATE: APRIL 29, 2020
REVISED: MAY 7, 2020

O'DRISCOLL
LAND SURVEYING, Inc.
LAND SURVEYING GPS MAPPING LAND COUNSULTING
46 COTTAGE MEDWAY, MASSACHUSETTS 02053 508-533-3314

FILE No.2085

May 12, 2020

Medway Planning & Economic Development Board Meeting

Choate Trail Subdivision – Public Hearing Continuation

- Public hearing continuation notice
- Connorstone Engineering letter dated 3-9-20 with submittal of revised plan
- Revised subdivision plan dated 3-9-20
- Tetra Tech review letter dated 3-26-20 on revised plan
- PGC review letter dated 3-31-20 on revised plan
- Existing Conditions sheet with large trees noted (received 4-3-20)
- Email dated 4-7-20 from abutter Amy Jordan
- Tax status certification from Medway Treasurer dated 4-6-20
- 4-28-20 email from Connorstone Engineer Vito Colonna with comments on draft decision
- REVISED draft decision dated 5-5-20

Medway Town Hall
155 Village Street
Medway, MA 02053
Phone (508) 533-3291
Fax (508) 321-4987
Email: planningboard@townofmedway.org
www.townofmedway.org

TOWN OF MEDWAY
COMMONWEALTH OF MASSACHUSETTS
PLANNING AND ECONOMIC DEVELOPMENT BOARD

MEMORANDUM
April 8, 2020

TO: Maryjane White, Town Clerk
Town of Medway Departments, Boards and Committees

FROM: Susy Affleck-Childs, Planning & Economic Development Coordinator

RE: ***Public Hearing Continuation: Choate Trail Way Definitive Subdivision Plan & Scenic Road Work Permit 42 and 42R Highland Street***
Continuation Date: Tuesday, May 12, 2020 at 7:00 p.m.
Location: Medway Town Hall, 155 Village Street

At its meeting on April 7, 2020, the Planning and Economic Development Board (PEDB) voted to continue the public hearings on the applications of The Residences at Choate Trail, LLC of Nashua, NH for approval of a scenic road work permit and a definitive subdivision plan for a proposed 4 lot residential subdivision to be located at 42 and 42R Highland Street. The hearing will take place at 7:00 p.m. during the regular PEDB meeting on Tuesday, May 12, 2020. The meeting will either be held in Sanford Hall at Medway Town Hall, 155 Village ST, Medway, MA or via remote participation on ZOOM.

Owned by The Residences at Choate Trail, LLC, the 5.88 acre parcel *(Medway Assessors Map 37, Parcels 67 & 64)* is located on the north side of Highland Street in the Agricultural Residential I zoning district. The *Choate Trail Way Definitive Subdivision Plan* is dated November 8, 2019, last revised March 9, 2020 and was prepared by Connorstone Engineering, Inc. of Northborough, MA. The plan shows the division of the property into four residential lots, one lot with the existing house at 42 Highland Street, and three new house lots with frontage on a proposed, 578' long permanent private road. The property includes wetland resources under the jurisdiction of the Medway Conservation Commission which is reviewing the proposed development for a Land Disturbance Permit and Order of Conditions.

The applications, definitive subdivision plan and associated documents for the proposed Choate Trail Way subdivision are on file with the Medway Town Clerk and at the Community and Economic Development Department at Medway Town Hall, 155 Village Street, Medway, MA and may be reviewed during regular business hours. The materials have also been posted to the Planning and Economic Development Board's page at the Town's web site at: https://www.townofmedway.org/planning-economic-development-board/pages/choate-trail-way-definitive-subdivision-plan.

We are in receipt of a revised plan dated March 9, 2020; it has been posted to the Board's web page. Kindly review that plan and provide comments to me at your earliest convenience. Please don't hesitate to contact me if you have any questions. Thanks.

CONNORSTONE ENGINEERING, INC.
10 SOUTHWEST CUTOFF, SUITE #7
NORTHBOROUGH, MASSACHUSETTS 01532
TEL: (508) 393-9727 • FAX: (508) 393-5242

Medway Planning & Economic Development Board
Town of Medway
155 Village Street
Medway, MA 02053

March 9, 2020

Re: 42 Highland Street (Choate Trail Way)
Revised Definitive Subdivision Plans

Dear Ms. Affleck-Childs:

On behalf of the applicant please find the enclosed plans related to the definitive subdivision application for Choate Trail Way. The plans have been revised based upon discussions at the previous Planning Board meeting.

Tree Mitigation:
The revised plans have been updated to include mitigation for the proposed scenic road tree removal. The plans have been modified slightly to protect the existing 14-inch Hickory on the right side of the entrance.

12" Dead Tree – no replacement required
5" Maple – to be transplanted
5" Maple – to be transplanted
26" Oak – 38 replacement trees required (3" caliper)
7" Maple – to be transplanted
9" Maple – to be transplanted
14" Hickory – to be protected (removal not required)
Total replacement required = 38 Trees

Proposed Mitigation Measure	Replacement Tree Equivalent
Preserve an existing 12" Maple along Highland Street. The tree is outside the right of way, but will be preserved and protected. If the replacement formula were applied to this tree it would require 8 replacement trees.	8 Trees
Buffer Restoration Area. Pre-existing disturbance of the inner 25 foot buffer to be planted with a mix of native shrubs Total shrubs = 30 (2:1 shrub to tree ratio)	15 Trees
Trail Buffer Plantings. Proposed planting buffer between the walking trail and the abutting residential property. Plantings to include native shrubs Total shrubs = 30 (2:1 shrub to tree ratio)	15 Trees

Total replacement tree equivalent = 38 Trees

Trail Connection:
The proposed walking trail connection has been provided on the plans. The trail will be located along the side of Lot 4 and consists of a 5 foot wide trail within a 15' wide easement. An easement over the sidewalk area has also been provided to access the trail entrance.

Other Plan Revisions:
The plans have also been revised based upon Conservation Commission comments and earlier Planning Board Comments these include:

Planning Board items:

- Switching the sidewalk to the east side of the road to reduce the limit of tree removal and earthwork toward the wetlands.
- Show the electric utility pole with overhead wires to the site and then underground connection.
- Specified the curbing type at the cul-de-sac as sloped granite.
- Added the street name as Copper Drive.

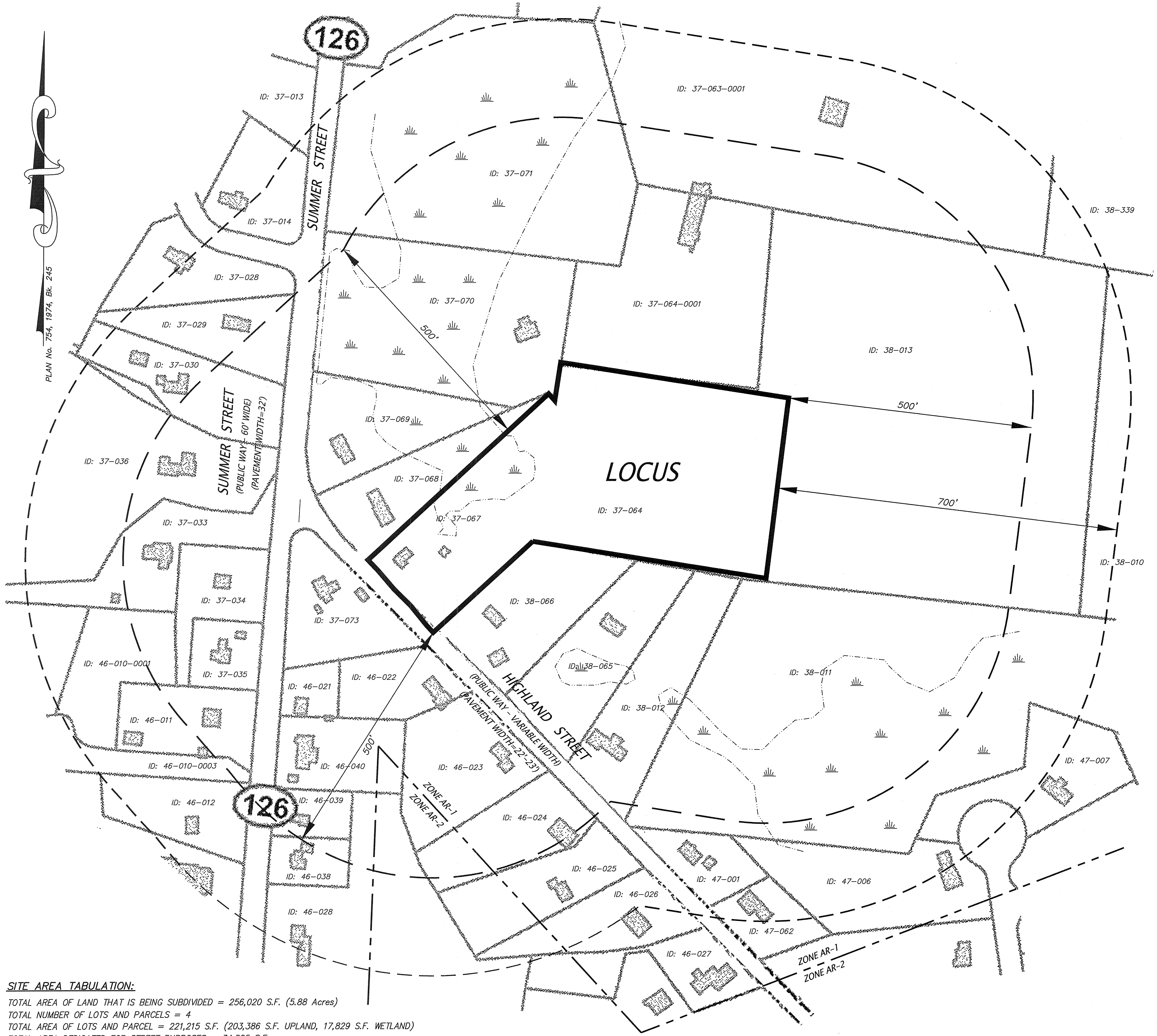
Conservation Commission Items:

- Modifying the wetland delineation (delete flag #10).
- Modify the erosion barrier detail to compost sock rather than straw wattles, and the limit of barriers on Lot 2 to correspond with the buffer zone limits.
- Note snow storage plowing away from wetland buffers toward the right shoulder.
- Note the existing house has been removed.
- Add a temporary sediment trap on Lot 4.
- Specify the side slope near the wetland to be seeded with a native conservation seed mix.

Should you have any questions please contact our office at 508-393-9727.

Sincerely,
Connorstone Engineering, Inc.

Vito Colonna, PE



APPROVAL UNDER THE SUBDIVISION CONTROL LAW, IS REQUIRED.
MEDWAY PLANNING AND ECONOMIC DEVELOPMENT BOARD

____

____

____

____

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DATE:

THIS PLAN IS SUBJECT TO A COVENANT TO BE RECORDED HEREWITH.

ABUTTERS LIST:

Parcel ID: 37-064 LOCK IT UP LLC 56 CENTRAL AVE UNIT 1 NEWTON, MA 02460	Parcel ID: 37-064-0001 MEDWAY TOWN OF MUNICIPAL 155 VILLAGE ST. MEDWAY, MA 02053	Parcel ID: 37-065 BANNON LYNDA MADGE JOHANNA 38 HIGHLAND ST. MEDWAY, MA 02053
Parcel ID: 37-066 JORDAN TRST JOSEPH E JORDAN TRST AMY L 40 HIGHLAND ST. MEDWAY, MA 02053	Parcel ID: 37-067 LOCK IT UP LLC 56 CENTRAL AVE UNIT 1 NEWTON, MA 02460	Parcel ID: 37-068 BABINEAU JR JAMES E BABINEAU MELISSA A 46 HIGHLAND ST. MEDWAY, MA 02053
Parcel ID: 37-069 HASSAN WILLIAM A. HASSAN SHEILA 50 HIGHLAND ST. MEDWAY, MA 02053	Parcel ID: 37-070 HAMM JOSEPH H & ALLYSON 48 HIGHLAND ST. MEDWAY, MA 02053	Parcel ID: 37-071 SEVEN R'S REALTY TRUST STEVEN & KERRI 165 VILLAGE ST. MEDWAY, MA 02053
Parcel ID: 37-073 BERARD COLETTE M TR BERARD NICOLE S TR 45 HIGHLAND STREET MEDWAY, MA 02053	Parcel ID: 38-011 MEDWAY TOWN OF CONSERVATION 155 VILLAGE ST. MEDWAY, MA 02053	Parcel ID: 38-012 COTE ERIC H. COTE ANDREA L. 36 HIGHLAND ST. MEDWAY, MA 02053
Parcel ID: 38-013 MEDWAY TOWN OF MUNICIPAL 155 VILLAGE ST. MEDWAY, MA 02053	Parcel ID: 46-021 NARCISSE JEAN BERNARD 64 SUMMER ST MEDWAY, MA 02053	Parcel ID: 46-022 MCMULLIN DANIEL B MCMULLIN STEPHANIE P O BOX 197 MEDWAY, MA 02053
Parcel ID: 46-023 DAVIS JR FRANCIS B C/O MARY FREEMAN 77 KERRY DRIVE SPRINGFIELD, MA 01118	Parcel ID: 46-040 NICKERSON DENNIS A NICKERSON SUSAN I 62 SUMMER ST. MEDWAY, MA 02053	Parcel ID: 37-033 SISTRAND JR. DAVID E SISTRAND RENEE 67-R SUMMER ST. MEDWAY, MA 02053
Parcel ID: 37-034 TENNANT CHERYL ANN 67 SUMMER ST. MEDWAY, MA 02053	Parcel ID: 37-035 MARSHALL WAYNE E MARSHALL SHEILA A 65 SUMMER ST. MEDWAY, MA 02053	Parcel ID: 37-036 LINDSEY LINDA A 69 SUMMER ST. MEDWAY, MA 02053

WAIVER LIST:

SECTION 7.13.3 WAIVER FROM THE REQUIREMENT OF PROVIDING A SIDEWALK ALONG THE FRONTAGE WITH HIGHLAND STREET.

SECTION 7.9.5.6 WAIVER TO ALLOW A VERTICAL CURVE WITH THE 200' LEVELING AREA.

I HEREBY CERTIFY THAT THIS PLAN WAS PREPARED IN CONFORMANCE WITH THE RULES AND REGULATIONS OF THE REGISTERS OF DEEDS.

3/6/20

VAROUJAN H. HAGOPIAN, P.L.S. 49665

COMMONWEALTH OF MASSACHUSETTS
VAROUJAN H. HAGOPIAN
No. 49665
PROFESSIONAL LAND SURVEYOR

I, ________________ CLERK OF THE TOWN OF MEDWAY RECEIVED AND RECORDED APPROVAL FROM THE PLANNING BOARD OF THIS PLAN ON ____________ AND NO APPEAL WAS TAKEN FOR TWENTY (20) DAYS THEREAFTER.

GRAPHIC SCALE: 1"=100'

0 50 75 100 150 200 300 400 500 FEET
0 10 20 30 40 50 75 100 125 150 METERS

SITE AREA TABULATION:

TOTAL AREA OF LAND THAT IS BEING SUBDIVIDED = 256,020 S.F. (5.88 Acres)
TOTAL NUMBER OF LOTS AND PARCELS = 4
TOTAL AREA OF LOTS AND PARCEL = 221,215 S.F. (203,386 S.F. UPLAND, 17,829 S.F. WETLAND)
TOTAL AREA DEDICATED FOR STREET PURPOSES = 34,805 S.F.
TOTAL AREA NOT INCLUDED FOR STREETS, LOTS OR PARCELS DEDICATED FOR DRAINAGE, SEWER, OR UTILITY EASEMENTS = 0 S.F.
TOTAL AREA RESERVED FOR OPEN SPACE, PARKS, SCHOOLS AND OTHER PUBLIC USE = 0 S.F.
SUMMARY: 221,215 S.F + 34,805 S.F. + 0 + 0 =256,020 S.F.

GENERAL NOTES:

1. OWNERS OF ADJOINING PROPERTIES ARE SHOWN ACCORDING TO CURRENT TOWN OF MEDWAY ASSESSORS RECORDS.
2. THIS PLAN IS BASED ON AN ON-THE-GROUND SURVEY BY CONNORSTONE ENGINEERING INC. PERFORMED IN MARCH 2018.
3. LEGAL STATUS OF EASEMENTS AND WAYS, NOT DETERMINED BY THIS SURVEY.
4. WETLANDS SHOWN HEREON WERE FLAGGED BY THREE OAKS ENVIRONMENTAL WETLAND CONSULTING AND LOCATED ON-THE-GROUND BY CONNORSTONE ENGINEERING INC.

SITE CONSTRCUTION NOTE:

1. ALL IMPROVEMENTS SHALL BE CONSTRUCTED IN ACCORDANCE WITH MASS HIGHWAY HANDICAP REQUIREMENTS AND THE CURRENT ADA/AAB REQUIREMENTS IN EFFECT AT THE TIME OF CONSTRUCTION.

ZONED: AR-1
AREA = 44,000 sf
FRONTAGE = 180 feet
SETBACKS: FRONT = 35 feet
SIDE = 15 feet
REAR = 15 feet

ASSESSOR MAP 37, LOT 67

OWNER / APPLICANT:

THE RESIDENCES AT CHOATE TRAIL, LLC
17 GOLDFINCH LANE
NASHUA, NH 03062

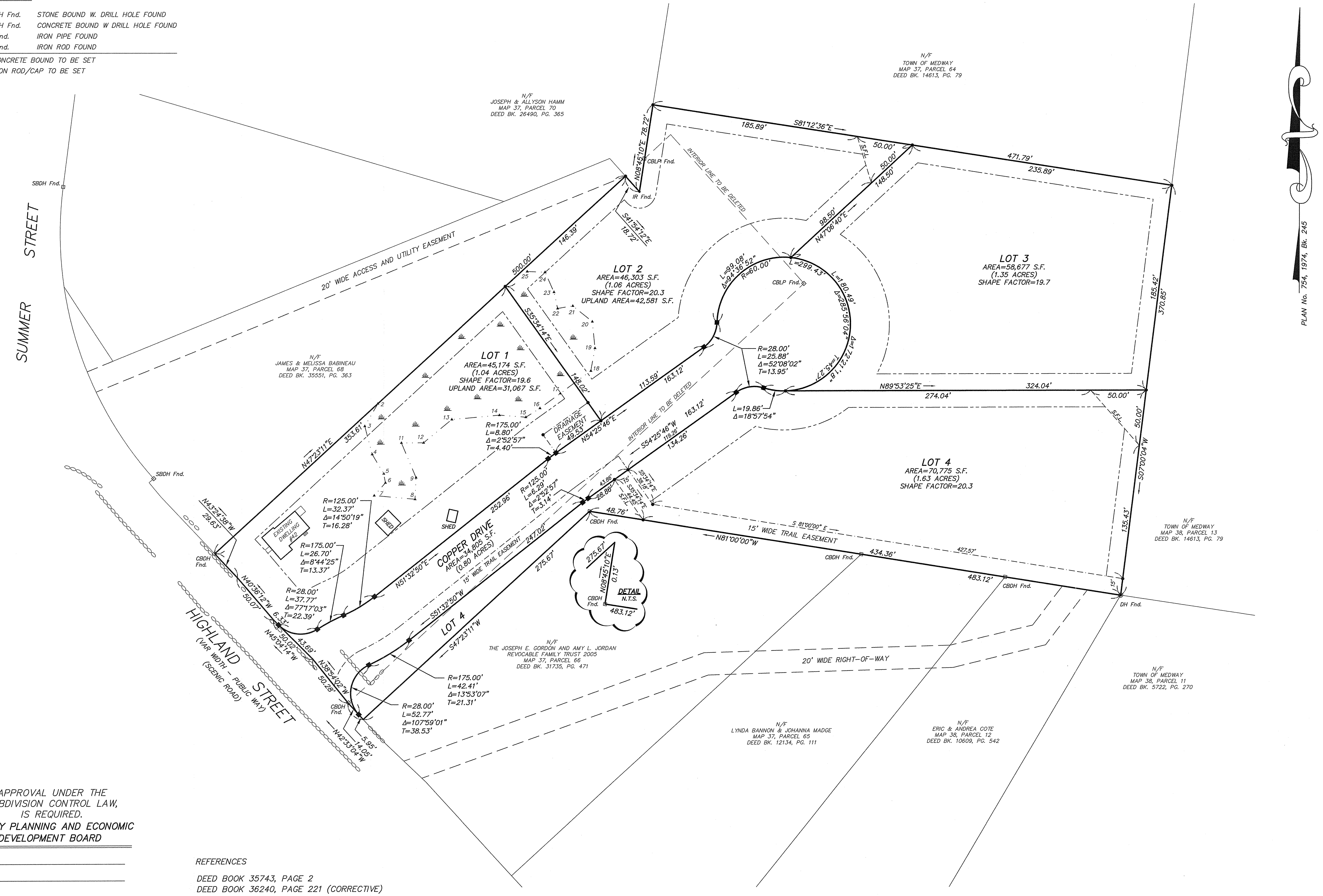
CONNORSTONE ENGINEERING INC.
CIVIL ENGINEERS AND LAND SURVEYORS
10 SOUTHWEST CUTOFF, SUITE 7
NORTHBOROUGH, MASSACHUSETTS 01532
PHONE: 508-393-9727 FAX: 508-393-5242

DEFINITIVE SUBDIVISION PLAN
COVER SHEET
CHOATE TRAIL WAY
IN
MEDWAY, MASS.

3/9/2020	REVIEW COMMENTS
1/13/2020	REVIEW COMMENTS
1/3/2020	REVIEW COMMENTS
REVISED:	DESCRIPTION:
DRAWN BY: REM	CHECK BY: VC
DATE: NOVEMBER 8, 2019	
SCALE: AS SHOWN	SHEET 1 OF 2

MONUMENTS

- SBDH Fnd. — STONE BOUND W. DRILL HOLE FOUND
- CBDH Fnd. — CONCRETE BOUND W DRILL HOLE FOUND
- IP Fnd. — IRON PIPE FOUND
- IR Fnd. — IRON ROD FOUND
- CONCRETE BOUND TO BE SET
- IRON ROD/CAP TO BE SET



GENERAL NOTES:

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ZONED: AR-1
AREA = 44,000 sf
FRONTAGE = 180 feet
SETBACKS: FRONT = 35 feet
SIDE = 15 feet
REAR = 15 feet

ASSESSOR MAP 37, LOT 67

OWNER / APPLICANT:
THE RESIDENCES AT CHOATE TRAIL, LLC
17 GOLDFINCH LANE
NASHUA, NH 03062

CONNORSTONE ENGINEERING INC.
CIVIL ENGINEERS AND LAND SURVEYORS
10 SOUTHWEST CUTOFF, SUITE 7
NORTHBOROUGH, MASSACHUSETTS 01532
PHONE: 508-393-9727 FAX: 508-393-5242

DEFINITIVE SUBDIVISION PLAN
LAND PLAN
CHOATE TRAIL WAY
IN
MEDWAY, MASS.

REVISED:	DESCRIPTION:
3/9/2020	REVIEW COMMENTS
1/13/2020	REVIEW COMMENTS
1/3/2020	REVIEW COMMENTS

DRAWN BY: REM CHECK BY: VC
DATE: NOVEMBER 8, 2019
SCALE: 1"=40' SHEET 2 OF 2.

APPROVAL UNDER THE SUBDIVISION CONTROL LAW, IS REQUIRED.
MEDWAY PLANNING AND ECONOMIC DEVELOPMENT BOARD

DATE:

THIS PLAN IS SUBJECT TO A COVENANT TO BE RECORDED HEREWITH.

REFERENCES

DEED BOOK 35743, PAGE 2
DEED BOOK 36240, PAGE 221 (CORRECTIVE)

PLAN NUMBER 754 OF 1974, PLAN BOOK 245
PLAN NUMBER 715 OF 1976, PLAN BOOK 257
PLAN NUMBER 246 OF 1995, PLAN BOOK 429
PLAN NUMBER 248 OF 1980, PLAN BOOK 280
PLAN NUMBER 841 OF 1995, PLAN BOOK 435
PLAN NUMBER 842 OF 1995, PLAN BOOK 435
NORFOLK COUNTY REGISTRY OF DEEDS

I HEREBY CERTIFY THAT THIS PLAN WAS PREPARED IN CONFORMANCE WITH THE RULES AND REGULATIONS OF THE REGISTERS OF DEEDS.

3/9/20

VAROUJAN H. HAGOPIAN, P.L.S. 49665

COMMONWEALTH OF MASSACHUSETTS
VAROUJAN H. HAGOPIAN
No. 49665
PROFESSIONAL LAND SURVEYOR

I, ______________ CLERK OF THE TOWN OF MEDWAY RECEIVED AND RECORDED APPROVAL FROM THE PLANNING BOARD OF THIS PLAN ON ____________ AND NO APPEAL WAS TAKEN FOR TWENTY (20) DAYS THEREAFTER.

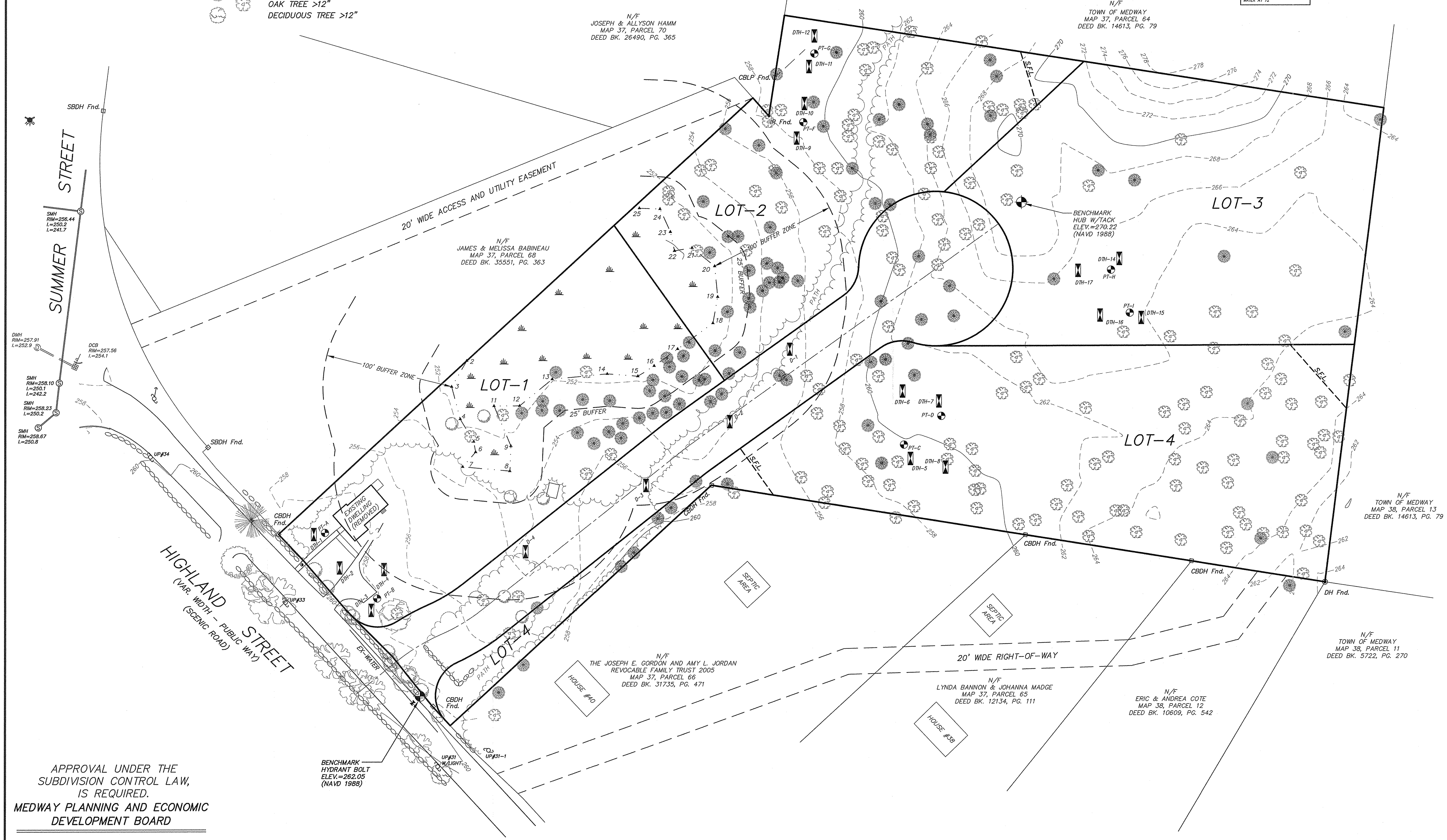
GRAPHIC SCALE: 1"=40'
0 10 20 30 40 50 75 100 150 200 FEET
0 5 10 15 20 30 40 50 60 METERS

LEGEND

	DRAIN MAN HOLE
	DRAINAGE LINE
	CATCH BASIN
	SEWER LINE
	SEWER MAN HOLE
	BITUMINOUS CURBING
	EDGE OF PAVEMENT
	GUARD RAIL
W	APPROX. WATERLINE
	HYDRANT
	WATERGATE
G	APPROX. GAS LINE
	GAS GATE
	UTILITY POLE & GUY WIRE
	CHAIN LINK FENCE
	LIGHTPOST
	HANDICAP SPACE
	ELECTRIC TRANSFORMER
	SIGN
	VERTICAL BENCHMARK
	TREELINE
×530.6	SPOT GRADE
3	WETLAND LINE
	TELEPHONE MAN HOLE
	MAPLE TREE >12"
	PINE TREE >12"
	OAK TREE >12"
	DECIDUOUS TREE >12"

MONUMENTS

	SBDH Fnd.	STONE BOUND W. DRILL HOLE FOUND
	CBDH Fnd.	CONCRETE BOUND W DRILL HOLE FOUND
	IP Fnd.	IRON PIPE FOUND
	IR Fnd.	IRON ROD FOUND



ZONED: AR-1
AREA = 44,000 sf
FRONTAGE = 180 feet
SETBACKS: FRONT = 35 feet
SIDE = 15 feet
REAR = 15 feet

ROAD

D-1 (11/7/19)			EL.=255.5
	0-8"	Ap	SANDY LOAM 10YR3/2
	8-28"	Bw	LOAMY SAND 10YR5/8
	28-62"	C1	LOAMY SAND 2.5Y5/6
	MOTTLES AT 36" REFUSAL AT 62"		
D-2 (11/7/19)			EL.=254.6
	0-8"	Ap	SANDY LOAM 10YR3/2
	8-30"	Bw	LOAMY SAND 10YR5/8
	30-70"	C1	LOAMY SAND 2.5Y5/6
	70-88"	C2	SANDY LOAM 2.5Y5/6
	MOTTLES AT 26" WATER AT 72"		
D-3 (11/7/19)			EL.=256.0
	0-10"	Ap	SANDY LOAM 10YR3/2
	10-28"	Bw	LOAMY SAND 10YR5/8
	28-82"	C1	LOAMY SAND 2.5Y5/4
	MOTTLES AT 42"		
D-4 (11/7/19)			EL.=254.0
	0-8"	Ap	SANDY LOAM 10YR3/2
	8-30"	Bw	LOAMY SAND 10YR5/8
	30-82"	C1	LOAMY SAND 2.5Y5/4
	MOTTLES AT 18" WATER AT 64"		

LOT 1

DTH-1 (7/8/19)			
	0-9"	Ap	SANDY LOAM 10YR3/2
	9-35"	Bw	LOAMY SAND 10YR6/8
	35-57"	C1	LOAMY SAND 10YR6/4
	57-122"	C2	SANDY LOAM 2.5Y5/4
	MOTTLES AT 47" NO REFUSAL		
DTH-2 (7/8/19)			
	0-17"		FILL
	17-35"	Bw	LOAMY SAND 10YR6/8
	35-56"	C1	LOAMY SAND 10YR6/4
	56-97"	C2	SANDY LOAM 2.5Y5/4
	MOTTLES AT 46" REFUSAL AT 97"		
DTH-3 (7/8/19)			
	0-9"		FILL
	9-23"	Bw	LOAMY SAND 10YR6/8
	23-92"	C1	SANDY LOAM 2.5Y5/4
	MOTTLES AT 45" REFUSAL AT 92"		
DTH-4 (7/8/19)			
	0-10"	Ap	SANDY LOAM 10YR3/2
	10-20"	Bw	LOAMY SAND 10YR6/8
	20-44"	C1	LOAMY SAND 10YR6/4
	44-113"	C2	SANDY LOAM 2.5Y5/4
	MOTTLES AT 37" NO REFUSAL		
PT-A (7/8/19)	DEPTH 66" 6 MPI		
PT-B (7/8/19)	DEPTH 52" 4 MPI		

LOT 2

DTH-9 (7/8/19)			
	0-6"	Ap	SANDY LOAM 10YR3/2
	6-32"	Bw	LOAMY SAND 10YR6/8
	32-112"	C1	LOAMY SAND 2.5Y5/4
	MOTTLES AT 94" NO REFUSAL		
DTH-10 (7/8/19)			
	0-6"	Ap	SANDY LOAM 10YR3/2
	6-32"	Bw	LOAMY SAND 10YR6/8
	32-109"	C1	LOAMY SAND 2.5Y5/4
	MOTTLES AT 84" NO REFUSAL		
DTH-11 (7/8/19)			
	0-6"	Ap	SANDY LOAM 10YR3/2
	6-24"	Bw	LOAMY SAND 10YR6/8
	24-93"	C1	SANDY LOAM 2.5Y5/4
	MOTTLES AT 84" NO REFUSAL		
DTH-12 (7/8/19)			
	0-5"	Ap	SANDY LOAM 10YR3/2
	5-31"	Bw	LOAMY SAND 10YR6/8
	31-88"	C1	LOAMY SAND 2.5Y5/4
	NO MOTTLES OR WATER REFUSAL AT 88"		
PT-F (7/8/19)	DEPTH 66" 6 MPI		
PT-G (7/8/19)	DEPTH 48" 6 MPI		

LOT 3

DTH-13 (7/8/19)			
	0-5"	Ap	SANDY LOAM 10YR3/2
	5-30"	Bw	LOAMY SAND 10YR6/8
	30-100"	C1	LOAMY SAND 2.5Y5/4
	NO MOTTLES OR WATER REFUSAL AT 100"		
DTH-14 (7/8/19)			
	0-6"	Ap	SANDY LOAM 10YR3/2
	6-35"	Bw	LOAMY SAND 10YR6/8
	35-105"	C1	LOAMY SAND 2.5Y5/4
	NO MOTTLES OR WATER REFUSAL AT 105"		
DTH-15 (7/8/19)			
	0-6"	Ap	SANDY LOAM 10YR3/2
	6-35"	Bw	LOAMY SAND 10YR6/8
	35-104"	C1	LOAMY SAND 2.5Y5/4
	NO MOTTLES OR WATER REFUSAL AT 104"		
DTH-16 (7/8/19)			
	0-6"	Ap	SANDY LOAM 10YR3/2
	6-27"	Bw	LOAMY SAND 10YR6/8
	27-81"	C1	LOAMY SAND 2.5Y5/4
	NO MOTTLES OR WATER REFUSAL AT 81"		
PT-H (7/8/19)	DEPTH 48" 3 MPI		
PT-I (7/8/19)	DEPTH 54" 2 MPI		

LOT 4

DTH-5 (7/8/19)			
	0-4"	Ap	SANDY LOAM 10YR3/2
	4-25"	Bw	LOAMY SAND 10YR6/8
	25-133"	C1	LOAMY SAND 2.5Y5/4
	MOTTLES AT 95" NO REFUSAL		
DTH-6 (7/8/19)			
	0-6"	Ap	SANDY LOAM 10YR3/2
	6-27"	Bw	LOAMY SAND 10YR6/8
	27-97"	C1	LOAMY SAND 2.5Y5/4
	NO MOTTLES OR WATER REFUSAL AT 97"		
DTH-7 (7/8/19)			
	0-7"	Ap	SANDY LOAM 10YR3/2
	7-31"	Bw	LOAMY SAND 10YR6/8
	31-112"	C1	LOAMY SAND 2.5Y5/4
	MOTTLES AT 81" NO REFUSAL		
DTH-8 (7/8/19)			
	0-5"	Ap	SANDY LOAM 10YR3/2
	5-26"	Bw	LOAMY SAND 10YR6/8
	26-61"	C1	FINE SAND 10YR7/1
	61-118"	C2	LOAMY SAND 2.5Y5/4
	MOTTLES AT 77", WATER AT 102" NO REFUSAL		
PT-C (7/8/19)	DEPTH 49" 5 MPI		
PT-D (7/8/19)	DEPTH 51" 5 MPI		

PLAN No. 754, 1974, Bk. 245

APPROVAL UNDER THE SUBDIVISION CONTROL LAW, IS REQUIRED.

MEDWAY PLANNING AND ECONOMIC DEVELOPMENT BOARD

DATE:

THIS PLAN IS SUBJECT TO A COVENANT TO BE RECORDED HEREWITH.

I, ________________ CLERK OF THE TOWN OF MEDWAY RECEIVED AND RECORDED APPROVAL FROM THE PLANNING BOARD OF THIS PLAN ON ____________ AND NO APPEAL WAS TAKEN FOR TWENTY (20) DAYS THEREAFTER.

GRAPHIC SCALE: 1"=40'

0 10 20 30 40 50 75 100 150 200 FEET

0 5 10 15 20 30 40 50 60 METERS

COMMONWEALTH OF MASSACHUSETTS VITO COLONNA No. 47635 REGISTERED PROFESSIONAL LAND SURVEYOR

3-9-20

ASSESSOR MAP 37, LOT 67

OWNER / APPLICANT:

THE RESIDENCES AT CHOATE TRAIL, LLC
17 GOLDFINCH LANE
NASHUA, NH 03062

CONNORSTONE ENGINEERING INC.

CIVIL ENGINEERS AND LAND SURVEYORS
10 SOUTHWEST CUTOFF, SUITE 7
NORTHBOROUGH, MASSACHUSETTS 01532
PHONE: 508-393-9727 FAX: 508-393-5242

DEFINITIVE SUBDIVISION PLAN EXISTING CONDITIONS CHOATE TRAIL WAY IN MEDWAY, MASS.

REVISED:	DESCRIPTION:
3/9/2020	REVIEW COMMENTS
1/13/2020	REVIEW COMMENTS
1/3/2020	REVIEW COMMENTS

DRAWN BY: REM CHECK BY: VC

DATE: NOVEMBER 8, 2019

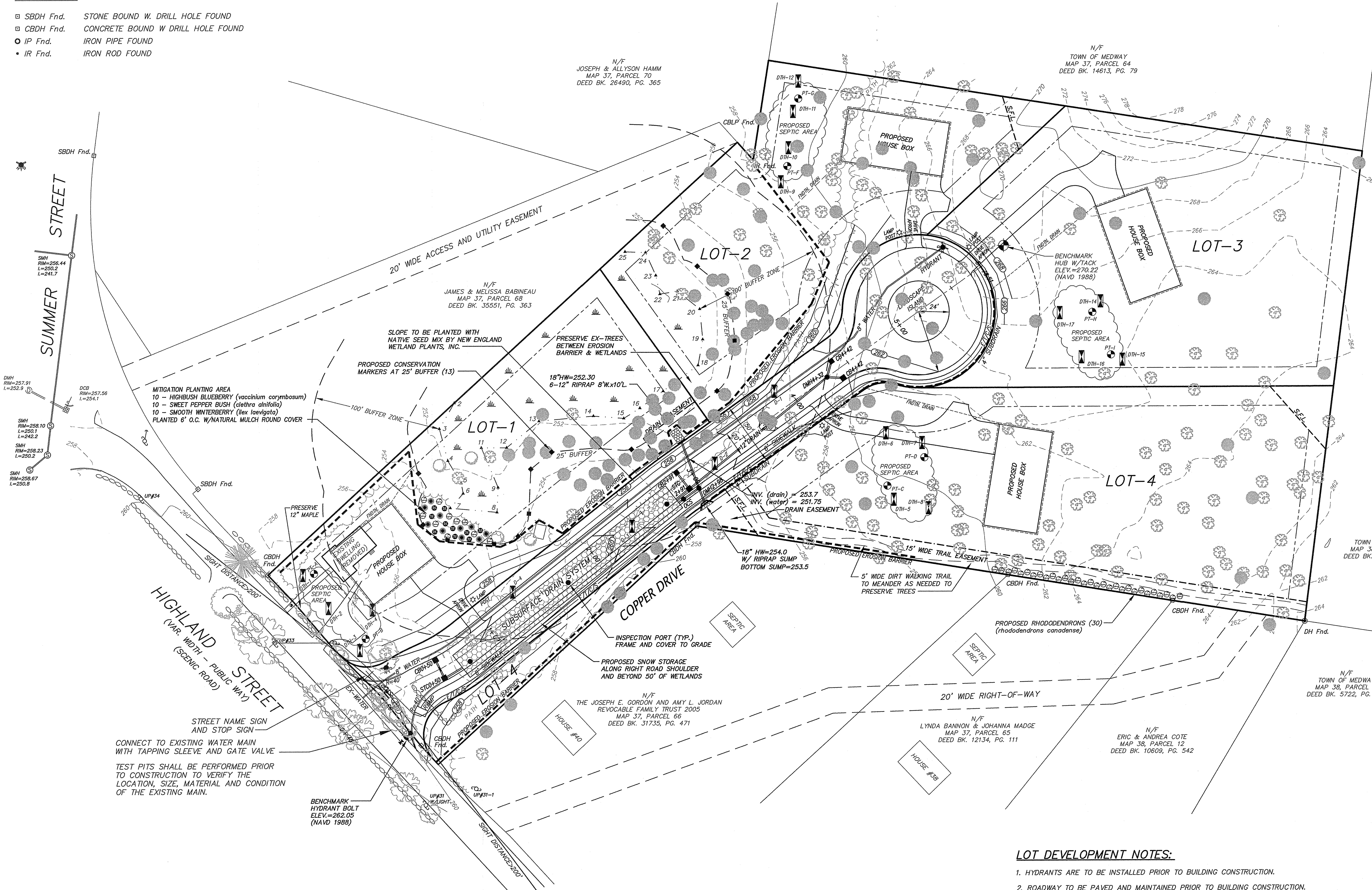
SCALE: 1"=40' SHEET 1 OF 7

MONUMENTS

- SBDH Fnd. — STONE BOUND W. DRILL HOLE FOUND
- CBDH Fnd. — CONCRETE BOUND W DRILL HOLE FOUND
- IP Fnd. — IRON PIPE FOUND
- IR Fnd. — IRON ROD FOUND

LEGEND

DRAIN MAN HOLE	UTILITY POLE & GUY WIRE
DRAINAGE LINE	CHAIN LINK FENCE
CATCH BASIN	LIGHTPOST
SEWER LINE	HANDICAP SPACE
SEWER MAN HOLE	ELECTRIC TRANSFORMER
BITUMINOUS CURBING	SIGN
EDGE OF PAVEMENT	VERTICAL BENCHMARK
GUARD RAIL	TREELINE
APPROX. WATERLINE	SPOT GRADE
HYDRANT	WETLAND LINE
WATERGATE	TELEPHONE MAN HOLE
APPROX. GAS LINE	MAPLE TREE >12"
GAS GATE	PINE TREE >12"
	OAK TREE >12"
	DECIDUOUS TREE >12"



ZONED: AR-1
AREA = 44,000 sf
FRONTAGE = 180 feet
SETBACKS: FRONT = 35 feet
SIDE = 15 feet
REAR = 15 feet

ASSESSOR MAP 37, LOT 67

OWNER / APPLICANT:
THE RESIDENCES AT CHOATE TRAIL, LLC
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NASHUA, NH 03062

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CIVIL ENGINEERS AND LAND SURVEYORS
10 SOUTHWEST CUTOFF, SUITE 7
NORTHBOROUGH, MASSACHUSETTS 01532
PHONE: 508-393-9727 FAX: 508-393-5242

DEFINITIVE SUBDIVISION PLAN
CONSTRUCTION PLAN
CHOATE TRAIL WAY
IN
MEDWAY, MASS.

REVISED:	DESCRIPTION:
3/9/2020	REVIEW COMMENTS
1/13/2020	REVIEW COMMENTS
1/3/2020	REVIEW COMMENTS

DRAWN BY: REM CHECK BY: VC
DATE: NOVEMBER 8, 2019
SCALE: 1"=40' SHEET 2 OF 7.

COMMONWEALTH OF MASSACHUSETTS VITO COLONNA No. 47635 REGISTERED PROFESSIONAL ENGINEER
3-9-20

LOT DEVELOPMENT NOTES:

1. HYDRANTS ARE TO BE INSTALLED PRIOR TO BUILDING CONSTRUCTION.
2. ROADWAY TO BE PAVED AND MAINTAINED PRIOR TO BUILDING CONSTRUCTION.
3. EACH LOT SHALL BE PROVIDED WITH A POST LIGHT AT THE DRIVEWAY ENTRANCE.
4. EACH LOT SHALL PROVIDE ROOF DRAIN DRYWELLS (SEE DETAIL).
5. NO DWELLING UNITS CAN BE CONSTRUCTED WITHOUT FIRST COORDINATING WITH THE MEDWAY BOARD OF HEALTH FOR THE PROPOSED SEPTIC SYSTEMS.

GRAPHIC SCALE: 1"=40'
0 10 20 30 40 50 75 100 150 200 FEET
0 5 10 15 20 30 40 50 60 METERS

APPROVAL UNDER THE SUBDIVISION CONTROL LAW, IS REQUIRED.
MEDWAY PLANNING AND ECONOMIC DEVELOPMENT BOARD

DATE: ____________

THIS PLAN IS SUBJECT TO A COVENANT TO BE RECORDED HEREWITH.

I, ____________ CLERK OF THE TOWN OF MEDWAY RECEIVED AND RECORDED APPROVAL FROM THE PLANNING BOARD OF THIS PLAN ON ____________ AND NO APPEAL WAS TAKEN FOR TWENTY (20) DAYS THEREAFTER.

LOT DEVELOPMENT NOTES:

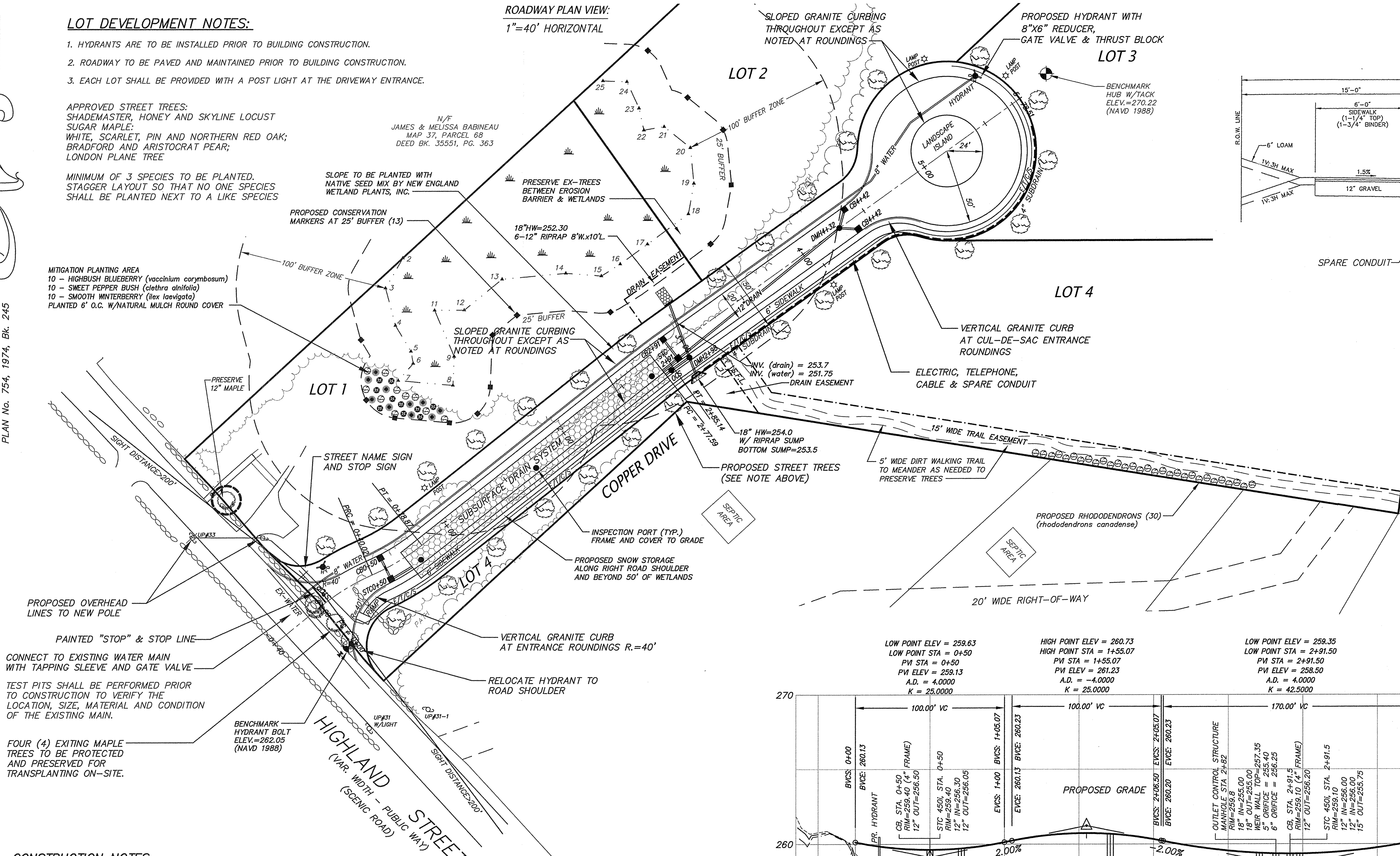
1. HYDRANTS ARE TO BE INSTALLED PRIOR TO BUILDING CONSTRUCTION.

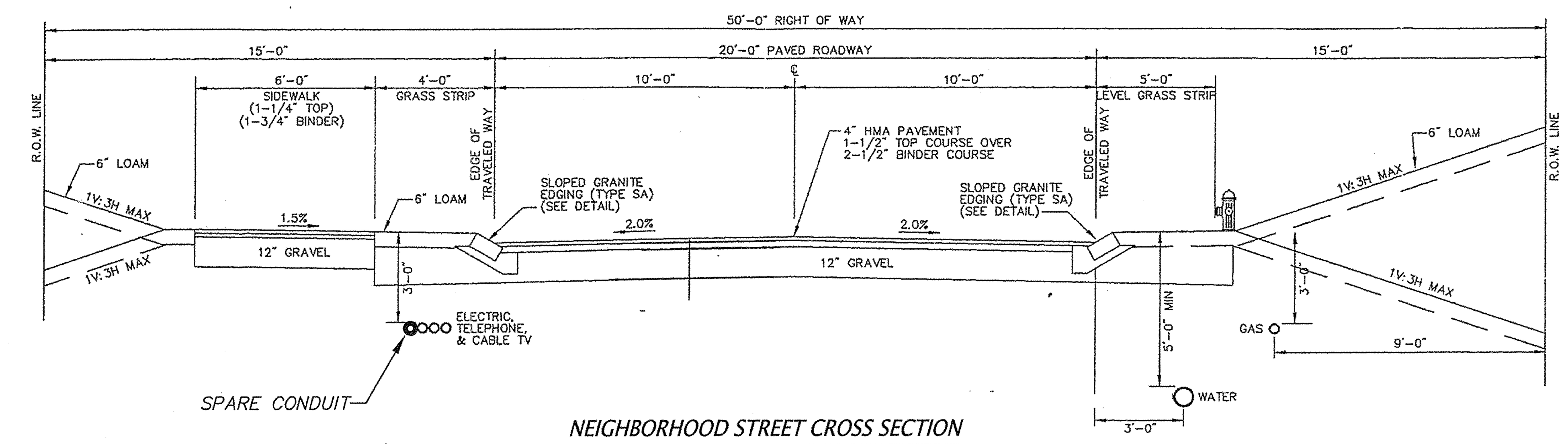
2. ROADWAY TO BE PAVED AND MAINTAINED PRIOR TO BUILDING CONSTRUCTION.

3. EACH LOT SHALL BE PROVIDED WITH A POST LIGHT AT THE DRIVEWAY ENTRANCE.

APPROVED STREET TREES:
SHADEMASTER, HONEY AND SKYLINE LOCUST
SUGAR MAPLE:
WHITE, SCARLET, PIN AND NORTHERN RED OAK;
BRADFORD AND ARISTOCRAT PEAR;
LONDON PLANE TREE

MINIMUM OF 3 SPECIES TO BE PLANTED.
STAGGER LAYOUT SO THAT NO ONE SPECIES
SHALL BE PLANTED NEXT TO A LIKE SPECIES





NEIGHBORHOOD STREET CROSS SECTION

NOT TO SCALE

NOTE: WHEN HYDRANTS ARE PROPOSED ON THE SIDEWALK SIDE OF THE ROADWAY THE HYDRANT MUST BE LOCATED ALONG THE BACK OF WALK, WITHIN ROADWAY LAYOUT IN ACCORDANCE WITH CURRENT ADA/AAB STANDARDS.

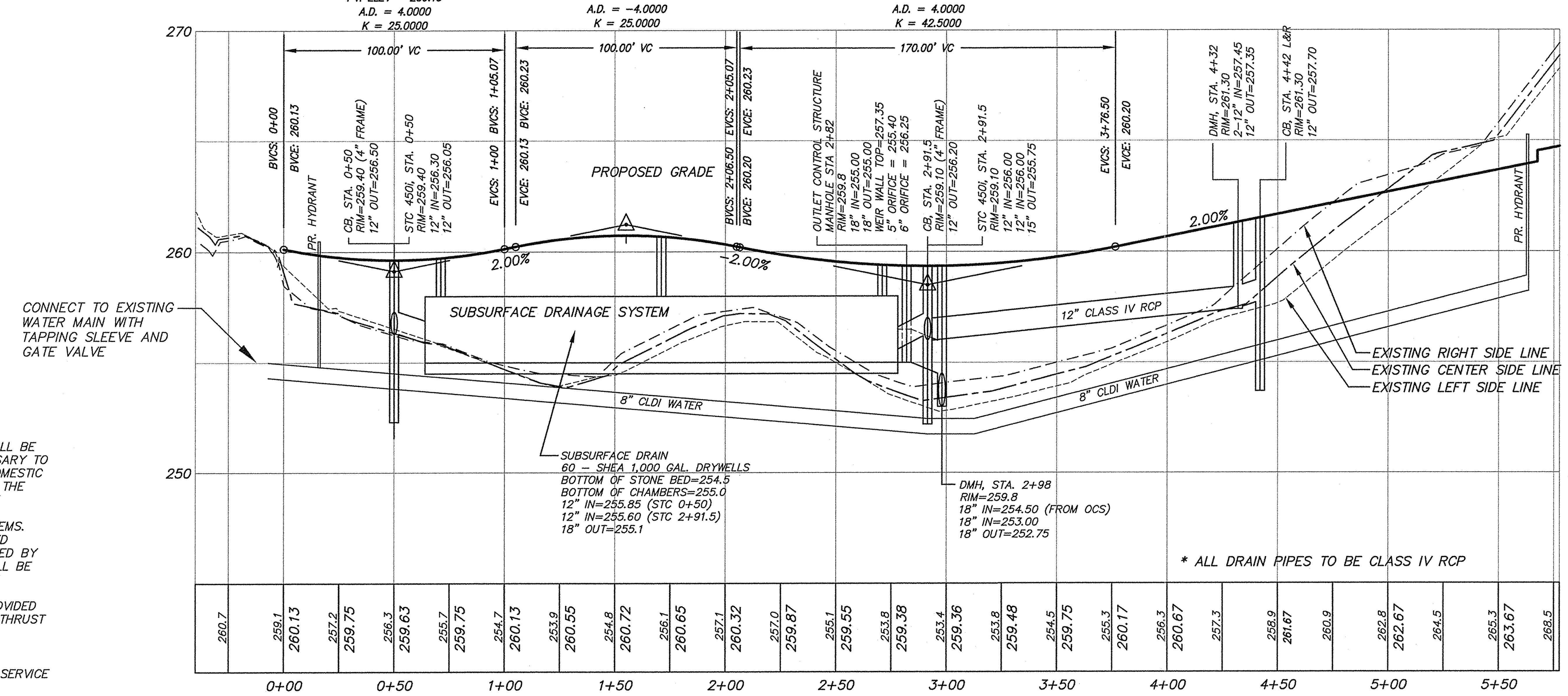
APPROVAL UNDER THE SUBDIVISION CONTROL LAW, IS REQUIRED.

MEDWAY PLANNING AND ECONOMIC DEVELOPMENT BOARD

DATE: ______________

THIS PLAN IS SUBJECT TO A COVENANT TO BE RECORDED HEREWITH.

ZONED: AR-1
AREA = 44,000 sf
FRONTAGE = 180 feet
SETBACKS: FRONT = 35 feet
SIDE = 15 feet
REAR = 15 feet



ROADWAY PROFILE:
1"=40' HORIZONTAL
1"=4' VERTICAL

CONSTRUCTION NOTES:

1. EXISTING UTILITY LINES SHOWN ON THIS DRAWING ARE FROM AVAILABLE INFORMATION AND ARE APPROXIMATE LOCATIONS. THE ENGINEER DOES NOT GUARANTEE THEIR ACCURACY OR THAT ALL UTILITIES AND SUBSURFACE STRUCTURES ARE SHOWN. THE CONTRACTOR SHALL VERIFY SIZE, LOCATION AND INVERT ELEVATIONS OF THE UTILITIES AND STRUCTURES, AS REQUIRED PRIOR TO THE START OF CONSTRUCTION. ANY DISCREPANCIES WITH RECORD DATA SHALL BE REPORTED TO THE ENGINEER IMMEDIATELY. THE CONTRACTOR SHALL CONTACT DIG SAFE: 1-800-344-7233 (72 HOURS BEFORE DIGGING), AND TOWN DPW FOR UTILITY LOCATIONS PRIOR TO EXCAVATION. TEST PITS SHALL BE UTILIZED FOR UTILITY CONNECTIONS.

2. ALL MATERIALS AND CONSTRUCTION PRACTICES SHALL BE IN CONFORMANCE WITH THE STANDARDS AND SPECIFICATIONS MEDWAY DEPARTMENT OF PUBLIC WORKS, OR THE LATEST EDITION OF THE MASSACHUSETTS HIGHWAY DEPARTMENT (MHD) CONSTRUCTION STANDARDS AND THE MHD "STANDARD SPECIFICATIONS FOR HIGHWAYS AND BRIDGES", WHICHEVER IS MORE STRINGENT.

3. THE LAYOUT AND INSTALLATION OF ELECTRIC, GAS, TELEPHONE AND CATV UTILITY CONNECTIONS AND SERVICES SHALL IN ACCORDANCE WITH THE REQUIREMENTS OF THE RESPECTIVE UTILITY.

4. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO COORDINATE HIS WORK WITH THE APPROPRIATE HIGHWAY & UTILITY DEPARTMENTS. CONTRACTOR SHALL MAINTAIN ALL EXISTING AND NEWLY INSTALLED UTILITIES IN GOOD WORKING ORDER AND SHALL PROTECT THEM FROM DAMAGE AT ALL TIMES UNTIL THE WORK IS COMPLETED AND ACCEPTED.

5. WORK WITHIN THE HIGHWAY LAYOUT, IF APPLICABLE, SHALL CONFORM TO THE CONDITIONS OF THE PERMIT ISSUED BY THE MASSACHUSETTS HIGHWAY DEPARTMENT AND/OR LOCAL AUTHORITY AS APPROPRIATE.

6. THE CONTRACTOR SHALL UTILIZE ALL MEASURES AND MATERIALS NECESSARY TO ENSURE THE SAFETY OF ALL PERSONS AND PROPERTIES AT THE SITE DURING CONSTRUCTION. ALL EXCAVATIONS SHALL CONFORM TO CURRENT OSHA STANDARDS.

7. ALL SIGN SIZES AND MATERIAL SHALL CONFORM TO THE "MANUAL ON UNIFORM TRAFFIC DEVICES" (MUTCD) AND THE OFFICE OF TRAFFIC OPERATIONS, FEDERAL HIGHWAY ADMINISTRATION, U.S. DEPARTMENT OF TRANSPORTATION.

8. ALL RAMPS, CURB CUTS, SIDEWALKS, AND ACCESSIBLE SPACES SHALL COMPLY WITH THE AMERICANS WITH DISABILITIES ACT REGULATIONS AND WITH ARCHITECTURAL ACCESS BOARD REGULATIONS (521 CMR 1-47).

9. ALL EXCAVATION AND EARTHWORK SHALL BE PERFORMED IN ACCORDANCE WITH THE LATEST EDITION OF THE MASSACHUSETTS HIGHWAY DEPARTMENT (MHD) STANDARD SPECIFICATIONS FOR HIGHWAYS AND BRIDGES, SECTIONS 120, 140, 150, AND 170.

WATER SYSTEM NOTES:

WATER MAINS, WITH HYDRANTS, VALVES AND OTHER FITTINGS, SHALL BE CONSTRUCTED AND INSTALLED WITHIN THE SUBDIVISION AS NECESSARY TO PROVIDE TO ALL LOTS THEREIN ADEQUATE WATER SUPPLY FOR DOMESTIC AND FIRE PROTECTION USE. WATER FACILITIES MUST CONFORM TO THE MEDWAY WATER RULES AND REGULATIONS, WHICH ARE UNDER THE JURISDICTION OF THE WATER AND SEWER DEPARTMENT. PROPER CONNECTIONS SHALL BE MADE WITH EXISTING PUBLIC WATER SYSTEMS. WATER LINES SHALL BE AT LEAST 8-INCH DIAMETER CEMENT-LINED DUCTILE IRON, CLASS 52 OR GREATER, OR AS CURRENTLY REQUIRED BY THE TOWN OF MEDWAY WATER AND SEWER DEPARTMENT AND SHALL BE FURNISHED WITH ADEQUATE VALVES AND APPURTENANCES TO THE SPECIFICATIONS OF THE TOWN OF MEDWAY WATER AND SEWER DEPARTMENT. MINIMUM FIVE FEET OF COVER SHALL BE PROVIDED OVER ALL PROPOSED WATER MAINS AND SERVICES. APPROPRIATE THRUST BLOCKING SHALL BE INSTALLED.

IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR, TO KEEP ACCURATE MEASUREMENTS / RECORDS OF THE WATER MAIN AND SERVICE INSTALLATION INLCUDING DEPTH, LOCATION, MATERIALS, ETC.

BOARD OF HEALTH NOTES:

NO DWELLING WILL BE CONSTRUCTED ON ANY LOT WITHOUT FIRST SECURING FROM THE BOARD OF HEALTH THE DISPOSAL WORKS CONSTRUCTION PERMIT REQUIRED BY TITLE 5 OF THE STATE ENVIRONMENTAL CODE

ADA / AAB REQUIREMENTS:

ALL IMPROVEMENTS, RAMPS, CURB CUTS, SIDEWALKS, AND DRIVEWAY CROSSINGS SHALL COMPLY WITH THE AMERICANS WITH DISABILITIES ACT REGULATIONS AND WITH ARCHITECTURAL ACCESS BOARD REGULATIONS (521 CMR S 1-47) IN FORCE AND EFFECTIVE AT THE TIME OF CONSTRUCTION.

I, ______________________ CLERK OF THE TOWN OF MEDWAY RECEIVED AND RECORDED APPROVAL FROM THE PLANNING BOARD OF THIS PLAN ON ______________________ AND NO APPEAL WAS TAKEN FOR TWENTY (20) DAYS THEREAFTER.

COMMONWEALTH OF MASSACHUSETTS
VITO COLONNA
No. 47635
REGISTERED PROFESSIONAL ENGINEER
3-9-20

ASSESSOR MAP 37, LOT 67

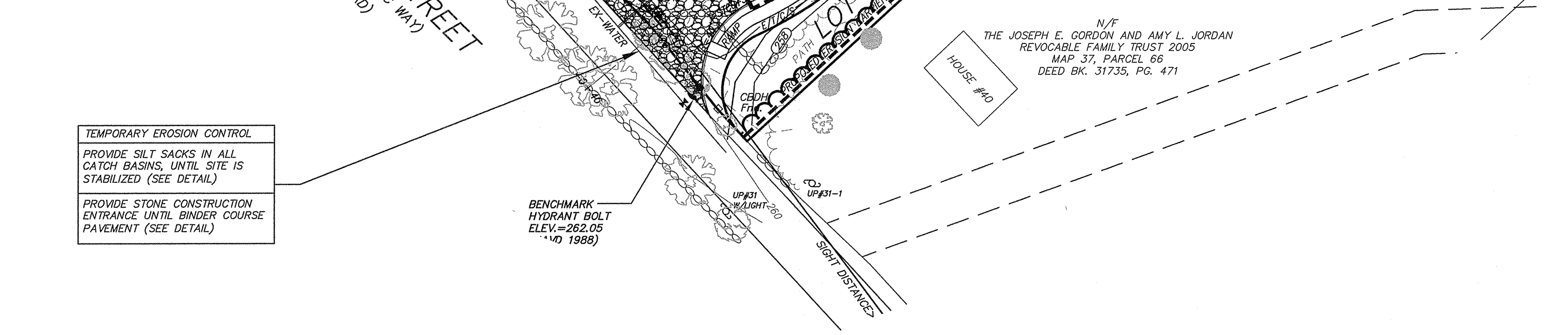
OWNER / APPLICANT:
THE RESIDENCES AT CHOATE TRAIL, LLC
17 GOLDFINCH LANE
NASHUA, NH 03062

CONNORSTONE ENGINEERING INC.
CIVIL ENGINEERS AND LAND SURVEYORS
10 SOUTHWEST CUTOFF, SUITE 7
NORTHBOROUGH, MASSACHUSETTS 01532
PHONE: 508-393-9727 FAX: 508-393-5242

DEFINITIVE SUBDIVISION PLAN
ROADWAY PLAN & PROFILE
CHOATE TRAIL WAY
IN
MEDWAY, MASS.

REVISED:	DESCRIPTION:
3/9/2020	REVIEW COMMENTS
1/13/2020	REVIEW COMMENTS
1/3/2020	REVIEW COMMENTS

DRAWN BY: REM | CHECK BY: VC
DATE: NOVEMBER 8, 2019
SCALE: 1"=40' | SHEET 3 OF 7.



ZONED: AR-1
AREA = 44,000 sf
FRONTAGE = 180 feet
SETBACKS: FRONT = 35 feet
SIDE = 15 feet
REAR = 15 feet

ASSESSOR MAP 37, LOT 67

EROSION AND SEDIMENTATION CONTROL NOTES:

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE ORDER OF CONDITIONS ISSUED BY THE TOWN OF MEDWAY CONSERVATION COMMISSION, AND THE PROJECT STORMWATER POLLUTION PREVENTION PLAN.

2. PRIOR TO INITIATING CONSTRUCTION, ALL SEDIMENTATION AND EROSION CONTROL MEASURES SHALL BE INSTALLED AS SHOWN ON THE PLANS AND DETAIL DRAWINGS.

3. THIS PLAN DEPICTS THE MINIMUM REQUIRED SEDIMENTATION AND EROSION CONTROLS. THE CONTRACTOR SHALL EMPLOY ADDITIONAL SEDIMENTATION AND EROSION CONTROL MEASURES AS NECESSITATED BY SITE CONDITIONS, OR AS DIRECTED BY THE OWNER, THE OWNER'S REPRESENTATIVE, OR THE CONSERVATION COMMISSION TO ENSURE PROTECTION OF ALL WETLAND RESOURCES AND CONTROL SEDIMENT TRANSPORT. IF SEDIMENTATION PLUMES OCCUR, THE CONTRACTOR SHALL STOP WORK AND INSTALL ADDITIONAL SEDIMENTATION CONTROL DEVICES IMMEDIATELY TO PREVENT FURTHER SEDIMENTATION.

4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING ALL TEMPORARY AND PERMANENT SEDIMENTATION AND EROSION CONTROLS UNTIL WORK IS COMPLETE AND ALL AREAS HAVE BEEN PERMANENTLY STABILIZED. AT SUCH TIME THE CONTRACTOR IS RESPONSIBLE FOR REMOVING ALL SEDIMENTATION AND EROSION CONTROL MEASURES.

5. THE CONTRACTOR SHALL INSPECT SEDIMENTATION AND EROSION CONTROLS ON A DAILY BASIS AND IMMEDIATELY AFTER EACH RAINFALL; REPAIRS SHALL BE MADE BY THE END OF THE WORKING DAY. ACCUMULATED SEDIMENT SHALL BE REMOVED AND DISPOSED OF BY THE CONTRACTOR WHEN THE VOLUME REACHES 1/4 TO 1/2 THE HEIGHT OF STRAWBALE OR SEDIMENT TRAP, OR AS DIRECTED BY THE LOCAL AUTHORITY.

6. SOIL STOCKPILES SHALL BE STABILIZED TO PREVENT EROSION, AND A PERIMETER SEDIMENT CONTROL BARRIER SHALL BE INSTALLED. NO MATERIALS SUBJECT TO EROSION SHALL BE STOCKPILED OVERNIGHT WITHIN 100 FEET OF A WETLAND UNLESS COVERED.

7. TOPSOIL STOCKPILES AND DISTURBED PORTIONS OF THE SITE WHERE CONSTRUCTION ACTIVITY TEMPORARILY CEASES FOR AT LEAST 7 DAYS WILL BE STABILIZED WITH A TEMPORARY SEED AND MULCH NO LATER THAN 7 DAYS FROM THE LAST CONSTRUCTION ACTIVITY IN THAT AREA. THE TEMPORARY SEED SHALL BE EROSION CONTROL MIX. DISTURBED PORTIONS OF THE SITE WHERE FINAL GRADE HAS BEEN MET AND CONSTRUCTION ACTIVITY CEASES SHALL BE STABILIZED WITH PERMANENT SEED NO LATER THAN 7 DAYS AFTER THE LAST CONSTRUCTION ACTIVITY. THE PERMANENT SEED MIX CONSISTS OF BLUEGRASS, TALL FESCUE, AND ANNUAL RYE. PRIOR TO SEEDING, GROUND AGRICULTURAL LIMESTONE SHALL BE APPLIED AS REQUIRED. SEEDING SHALL BE NUTRIENT ENRICHED HYDROSEED AND CELLULOSE OR OTHER DEGRADABLE FIBERS CAPABLE OF RETAINING MOISTURE. IF NOT DURING THE GROWING SEASON, THESE AREAS SHALL BE MULCHED WITH STRAW AND SECURED.

8. DEWATERING OPERATIONS, IF REQUIRED, SHALL DISCHARGE ONTO STABILIZED AREAS, AND ALL DISCHARGE WATER IS TO PASS THROUGH SEDIMENTATION CONTROL DEVICES TO PREVENT IMPACTS UPON WATER BODIES, BORDERING VEGETATED WETLANDS, DRAINAGE SYSTEMS AND ABUTTING PROPERTIES. AT A MINIMUM ALL DISCHARGES SHALL BE INTERCEPTED BY STRAWBALE CORRAL AND STRAWBALE CHECK DAMS SPACED 10' APART.

9. STRAW WATTLES AND SILT FENCE SHALL BE INSTALLED ALONG THE EDGE OF PROPOSED DEVELOPMENT OR AS INDICATED ON THE PLANS. ADDITIONAL BARRIERS SHALL BE LOCATED AS CONDITIONS WARRANT, AND IN SOME AREAS WEED FREE BALE/SILT FENCING STRUCTURES MAY HAVE TO BE DUPLICATED AT REGULAR INTERVALS UP GRADIENT OF WETLANDS.

10. STREET SWEEPING IN THE VICINITY OF THE PROJECT AREA SHALL BE PERFORMED AS NEEDED UNTIL THE PROJECT LIMITS HAVE BEEN STABILIZED. ALL SEDIMENT TRACKED ONTO PUBLIC RIGHT-OF-WAYS SHALL BE SWEPT AT THE END OF EACH WORKING DAY.

11. ALL EXISTING AND PROPOSED DRAINAGE SYSTEM INLETS, WHICH MAY RECEIVE STORMWATER FLOW FROM DISTURBED AREAS, SHALL BE PROVIDED WITH INLET PROTECTION (CATCH BASIN SILT SACKS). THE CONTRACTOR SHALL MAINTAIN THESE DEVICES PER THE MANUFACTURERS RECOMMENDATIONS UNTIL ALL WORK IS COMPLETED AND ALL AREAS HAVE BEEN ADEQUATELY STABILIZED.

12. DUST CONTROL MEASURES SHALL BE IMPLEMENTED AND MAINTAINED PROPERLY THROUGHOUT DRY WEATHER PERIODS UNTIL ALL DISTURBED AREAS HAVE BEEN PERMANENTLY STABILIZED. METHODS FOR DUST CONTROL SHALL INCLUDE WATER SPRINKLING AND/OR OTHER METHODS APPROVED BY THE ENGINEER.

13. ALL VEHICLES SHALL ENTER AND EXIT THE SIT VIA THE STABILIZED CONSTRUCTION ENTRANCE CONSISTING OF 2" TO 3" INCH CRUSHED STONE TO A DEPTH OF 6" FOR A MINIMUM OF THE FIRST 50 FEET FROM EXISTING PAVED STREETS. EXTEND THE PAD BEYOND 50 FEET AS NECESSARY BASED UPON FIELD CONDITIONS. IF THE SITE CONDITIONS ARE SUCH THAT THE GRAVEL PAD DOES NOT REMOVE THE MAJORITY OF THE MUD AND DEBRIS, THEN THE TIRES SHALL BE WASHED BEFORE ANY VEHICLES ENTER ADJACENT ROADWAYS. ALL WATER USED FOR TIRE WASHING SHALL BE COLLECTED AND TREATED PRIOR TO ENTERING THE DRAINAGE SYSTEM. THE CONTRACTOR SHALL INSPECT THE CONSTRUCTION ENTRANCE DAILY AND AFTER HEAVY USE.

14. EQUIPMENT NOT IN USE SHALL NOT BE PARKED WITHIN WETLANDS OR BUFFER AREAS.

APPROVAL UNDER THE
SUBDIVISION CONTROL LAW,
IS REQUIRED.
MEDWAY PLANNING AND ECONOMIC DEVELOPMENT BOARD

____

____

____

____

____

DATE: ______________________

THIS PLAN IS SUBJECT TO A COVENANT TO BE RECORDED HEREWITH.

I, ______________________ CLERK OF THE TOWN OF MEDWAY RECEIVED AND RECORDED APPROVAL FROM THE PLANNING BOARD OF THIS PLAN ON ______________________ AND NO APPEAL WAS TAKEN FOR TWENTY (20) DAYS THEREAFTER.

GENERAL SEQUENCING PLAN

ESTIMATED SCHEDULE:
ROADWAY THROUGH BINDER COURSE: 12 MONTHS
LOT DEVELOPMENT 24 MONTHS

1. INSTALL SEDIMENT CONTROL BARRIERS AND CONSTRUCTION ENTRANCE.
2. REMOVE THE EXISTING STRUCTURES AND PAVEMENT AREAS.
3. INSTALL TEMPORARY SEDIMENT BASINS (IF REQUIRED)
4. CLEAR, STUMP & GRUB ROADWAY AREAS.
5. BEGIN CONSTRUCTION OF ROADWAY.
6. INSTALL UTILITIES. DRYWELL TO REMAIN OFF-LINE UNTIL THE DRAINAGE AREA IS STABILIZED.
7. INSTALL GRAVEL BASE AND BINDER COURSE PAVEMENT.
8. INDIVIDUAL LOT DEVELOPMENT.
9. PERFORM FINAL LANDSCAPING AND STABILIZATION.
10. FINAL TOP COURSE PAVEMENT.
11. REMOVE THE REMAINING SILTATION DEVISES AS THE AREA BECOMES STABLE.

COMMONWEALTH OF MASSACHUSETTS
VITO COLONNA
No. 47635
REGISTERED PROFESSIONAL ENGINEER
3-9-20

OWNER / APPLICANT:
THE RESIDENCES AT CHOATE TRAIL, LLC
17 GOLDFINCH LANE
NASHUA, NH 03062

CONNORSTONE ENGINEERING INC.
CIVIL ENGINEERS AND LAND SURVEYORS
10 SOUTHWEST CUTOFF, SUITE 7
NORTHBOROUGH, MASSACHUSETTS 01532
PHONE: 508-393-9727 FAX: 508-393-5242

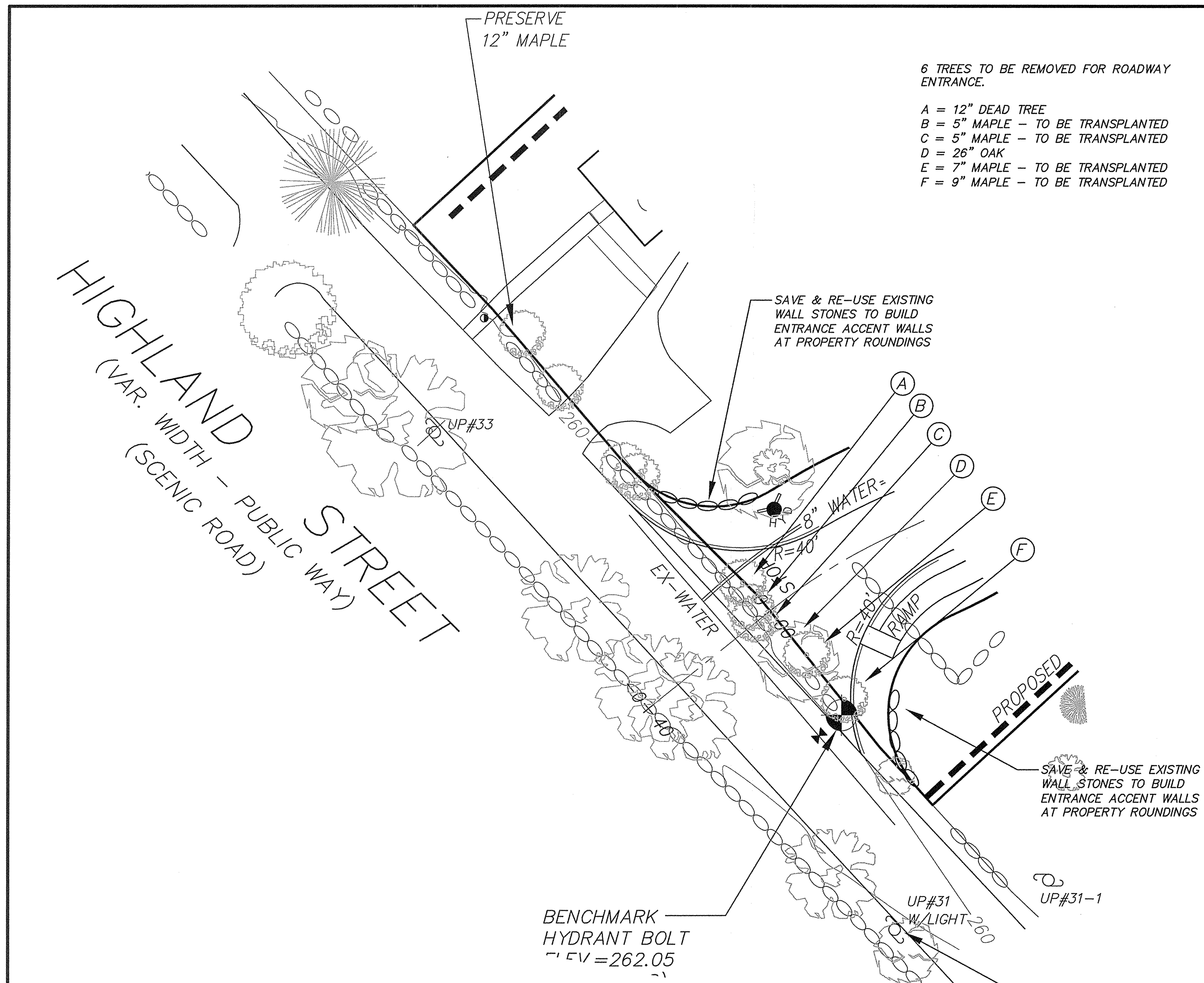
DEFINITIVE SUBDIVISION PLAN
EROSION CONTROL PLAN
CHOATE TRAIL WAY
IN
MEDWAY, MASS.

REVISED:	DESCRIPTION:
3/9/2020	REVIEW COMMENTS
1/13/2020	REVIEW COMMENTS
1/3/2020	REVIEW COMMENTS

DRAWN BY: REM | CHECK BY: VC

DATE: NOVEMBER 8, 2019

SCALE: 1"=40' | SHEET 4 OF 7.



6 TREES TO BE REMOVED FOR ROADWAY ENTRANCE.

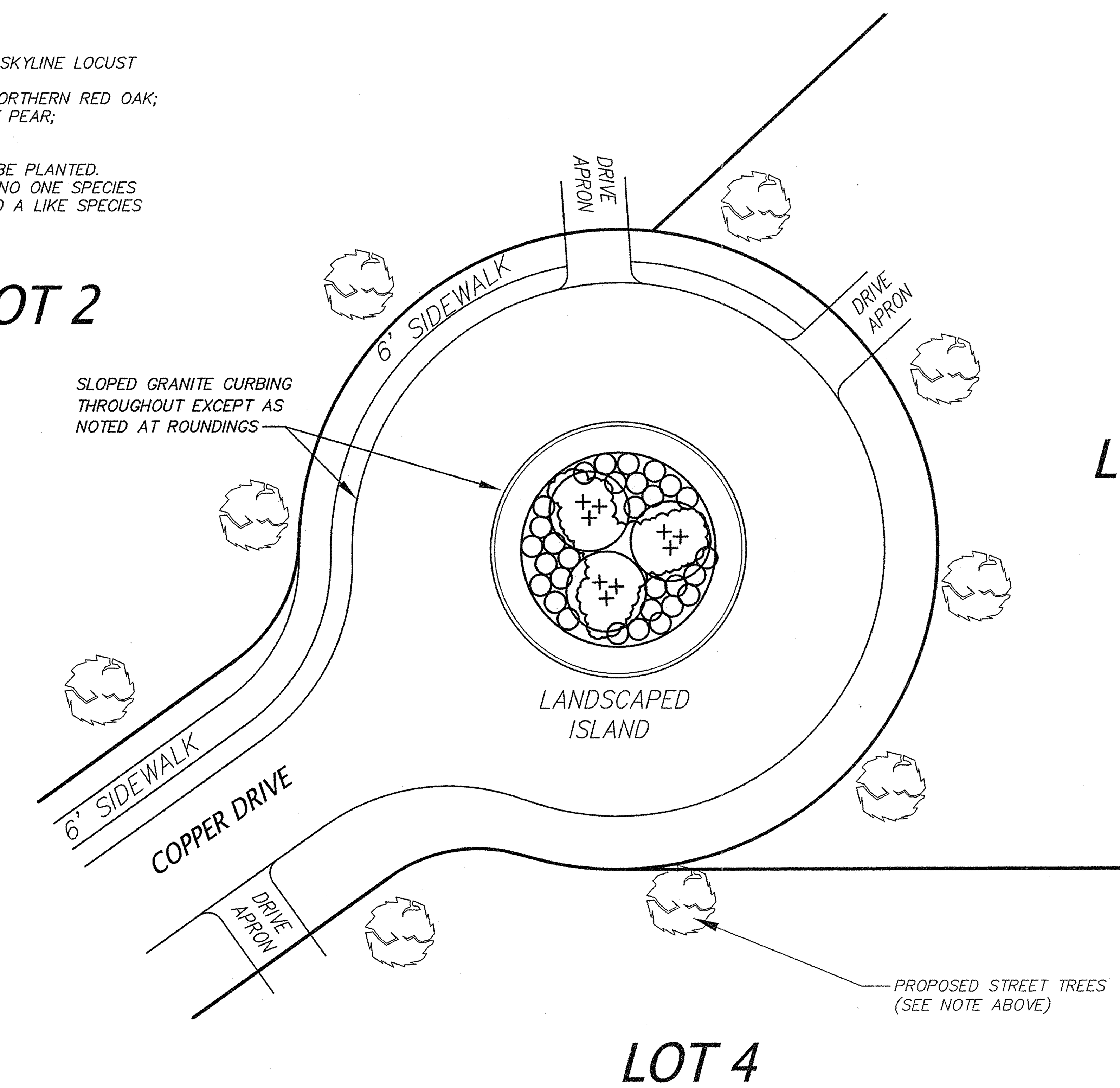
A = 12" DEAD TREE
B = 5" MAPLE – TO BE TRANSPLANTED
C = 5" MAPLE – TO BE TRANSPLANTED
D = 26" OAK
E = 7" MAPLE – TO BE TRANSPLANTED
F = 9" MAPLE – TO BE TRANSPLANTED

SCENIC ROAD INTERSECTION PLAN

SCALE: 1"=20'

APPROVED STREET TREES:
SHADEMASTER, HONEY AND SKYLINE LOCUST
SUGAR MAPLE:
WHITE, SCARLET, PIN AND NORTHERN RED OAK;
BRADFORD AND ARISTOCRAT PEAR;
LONDON PLANE TREE

MINIMUM OF 3 SPECIES TO BE PLANTED.
STAGGER LAYOUT SO THAT NO ONE SPECIES
SHALL BE PLANTED NEXT TO A LIKE SPECIES



PLANT LIST

Qty	Botanical Name	Common Name	Size
CUL-DE-SAC ISLAND			
3	Syringa reticulata	Japanese Tree Lilac	Multi-10-12'
24	Ilex verticillata 'Red Sprite'	Red Sprite Winterberry	2-2.5'
6	Ilex verticillata 'Jim Dandy'	Jim Dandy Winterberry	2-2.5'
tbd	Hemerocallis 'Happy Returns'	Longblooming Daylily	#1 pot

CUL-DE-SAC PLANTING PLAN

SCALE: 1"=20'

APPROVAL UNDER THE
SUBDIVISION CONTROL LAW,
IS REQUIRED.
MEDWAY PLANNING AND ECONOMIC
DEVELOPMENT BOARD

DATE:

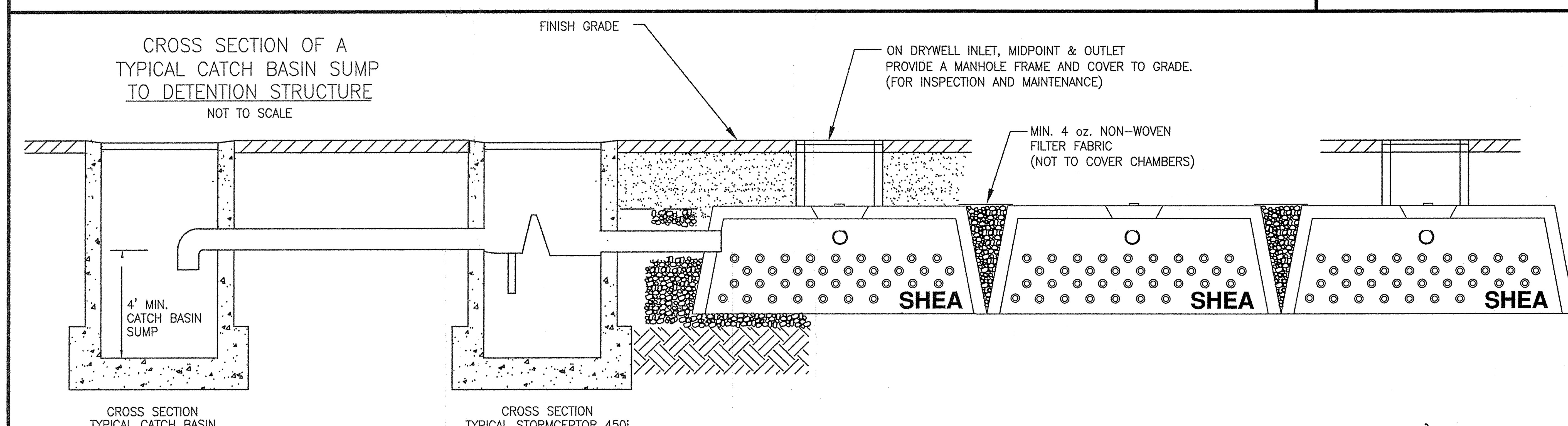
THIS PLAN IS SUBJECT TO A COVENANT TO BE RECORDED HEREWITH.

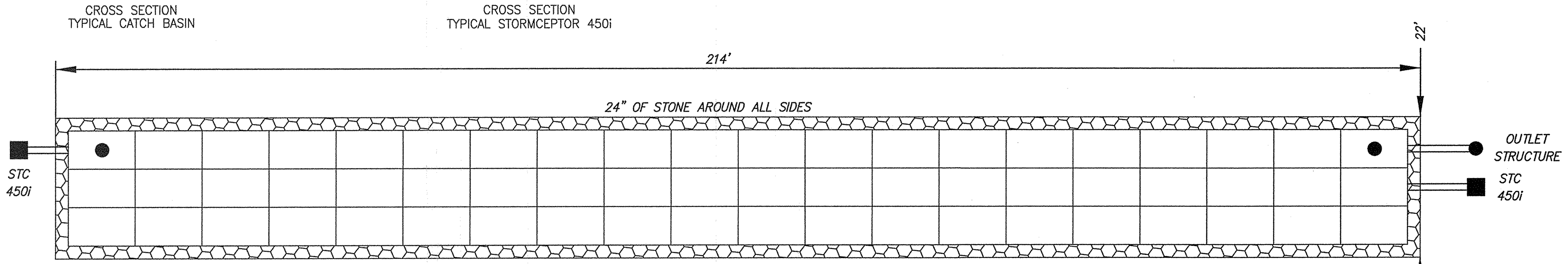
COMMONWEALTH OF MASSACHUSETTS
VITO COLONNA
No. 47635
REGISTERED PROFESSIONAL ENGINEER
3-9-20

ZONED: AR-1
AREA = 44,000 sf
FRONTAGE = 180 feet
SETBACKS: FRONT = 35 feet
SIDE = 15 feet
REAR = 15 feet

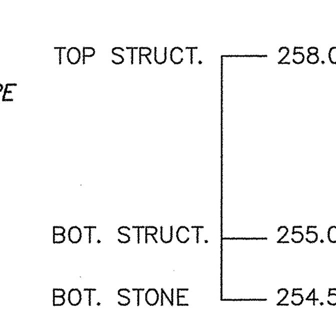
ASSESSOR MAP 37, LOT 67

CROSS SECTION OF A
TYPICAL CATCH BASIN SUMP
TO DETENTION STRUCTURE
NOT TO SCALE

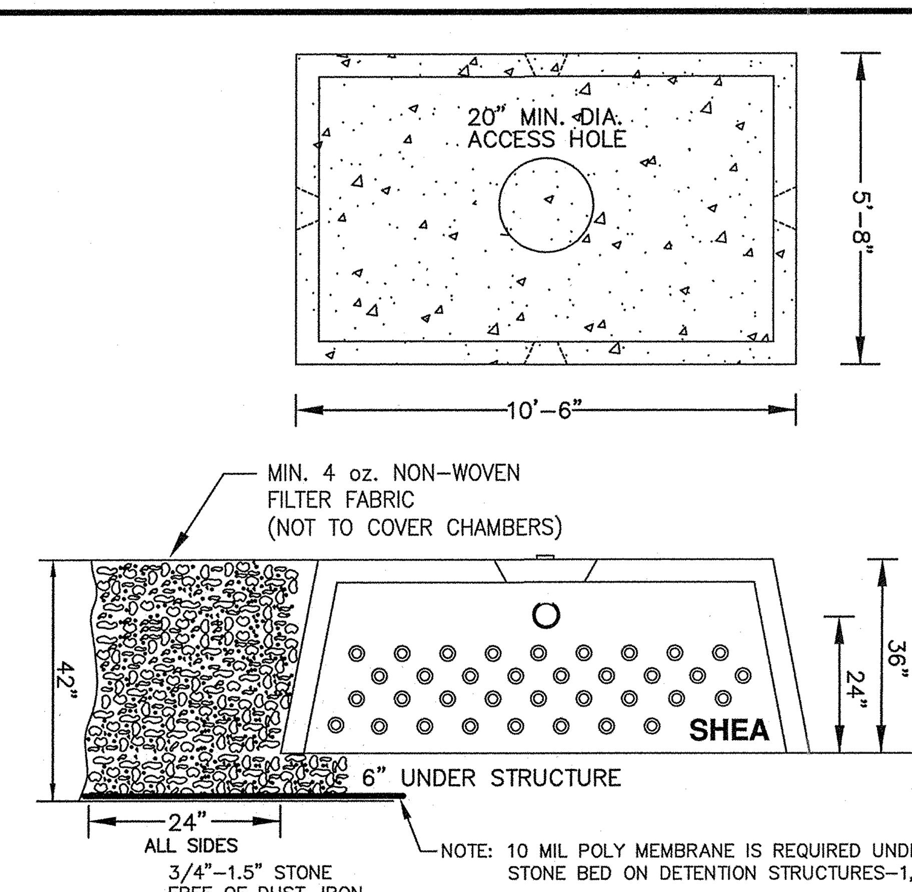




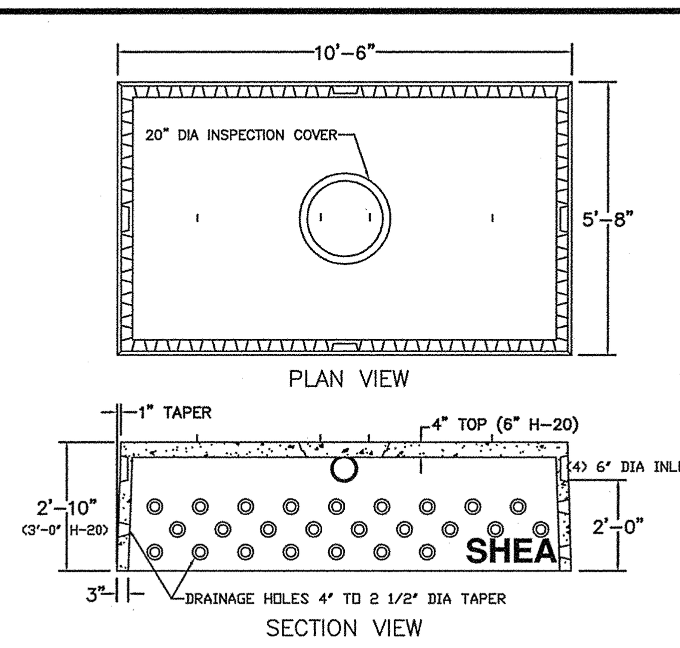
SCHEMATIC LAYOUT



CHAMBER ELEVATIONS



INFILTRATION STRUCTURE
NOT TO SCALE



NOTES:
1. CONCRETE: 4,000 PSI MINIMUM AFTER 28 DAYS.
2. ALSO AVAILABLE IN H-20 LOADING.

ITEM NO. DW-JDWH H-20

DRY WELL JUMBO

SHEA CONCRETE PRODUCTS, INC.

I, ______________ CLERK OF THE TOWN OF MEDWAY RECEIVED AND RECORDED APPROVAL FROM THE PLANNING BOARD OF THIS PLAN ON ______________ AND NO APPEAL WAS TAKEN FOR TWENTY (20) DAYS THEREAFTER.

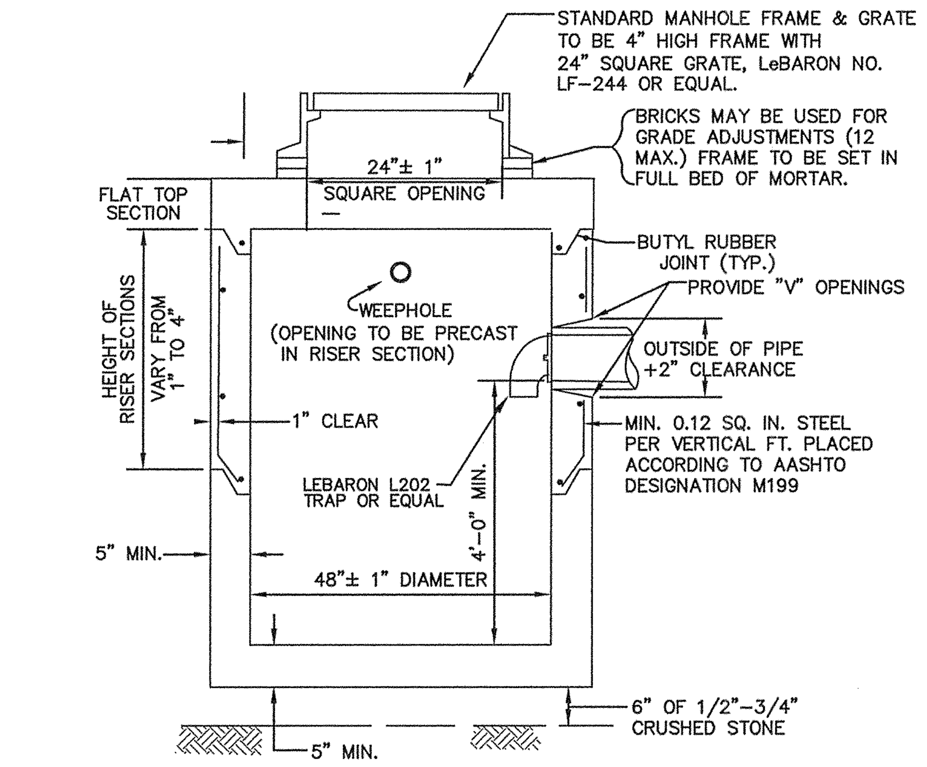
OWNER / APPLICANT:
THE RESIDENCES AT CHOATE TRAIL, LLC
17 GOLDFINCH LANE
NASHUA, NH 03062

CONNORSTONE ENGINEERING INC.
CIVIL ENGINEERS AND LAND SURVEYORS
10 SOUTHWEST CUTOFF, SUITE 7
NORTHBOROUGH, MASSACHUSETTS 01532
PHONE: 508-393-9727 FAX: 508-393-5242

DEFINITIVE SUBDIVISION PLAN
SITE DETAIL PLAN
CHOATE TRAIL WAY
IN
MEDWAY, MASS.

REVISED:	DESCRIPTION:
3/9/2020	REVIEW COMMENTS
1/13/2020	REVIEW COMMENTS
1/3/2020	REVIEW COMMENTS

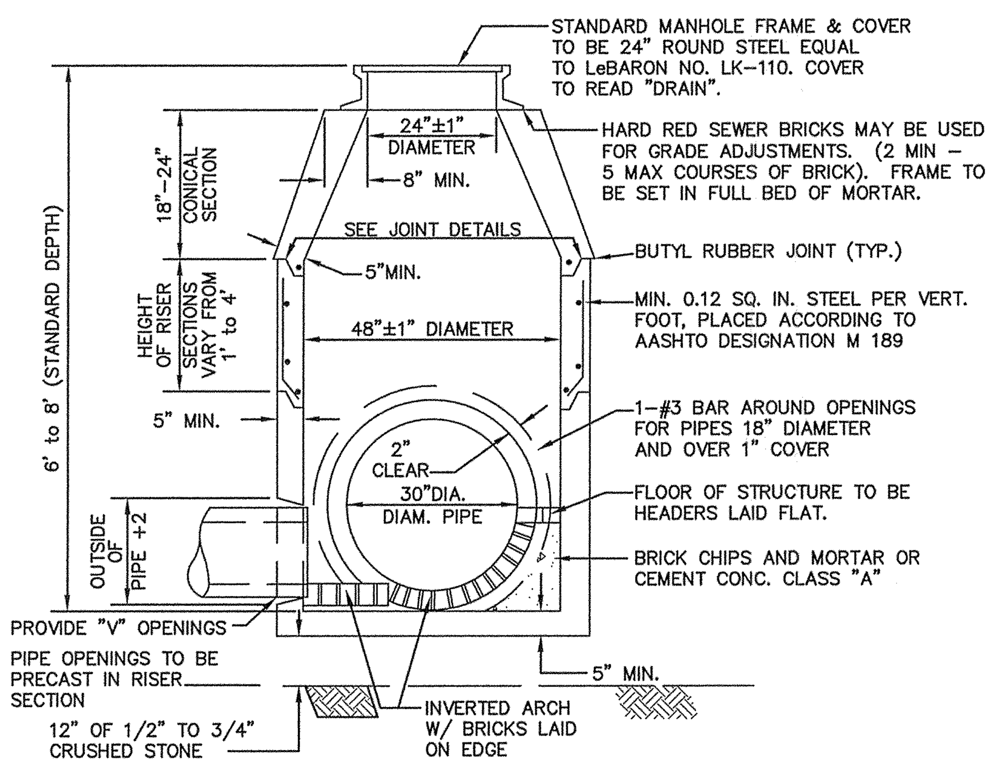
DRAWN BY: REM | CHECK BY: VC
DATE: NOVEMBER 8, 2019
SCALE: 1"=40' | SHEET 5 OF 7.



NOTE: NO BELL ENDS IN CATCH BASIN. CONNECTIONS TO BE TIGHTLY SEALED WITH MORTAR.

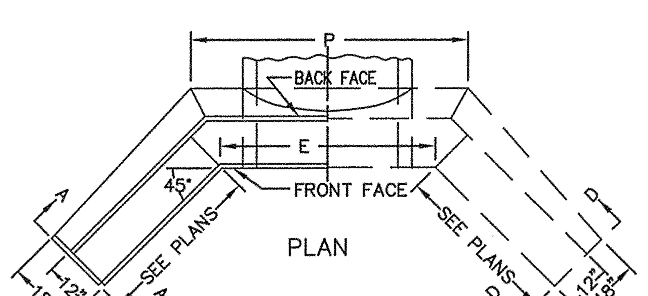
PRECAST CONCRETE DRAIN CATCH BASIN DETAIL

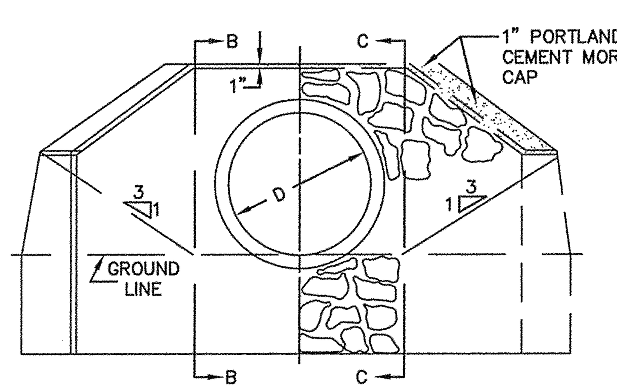
NOT TO SCALE



PRECAST CONCRETE DRAIN MANHOLE DETAIL

NOT TO SCALE

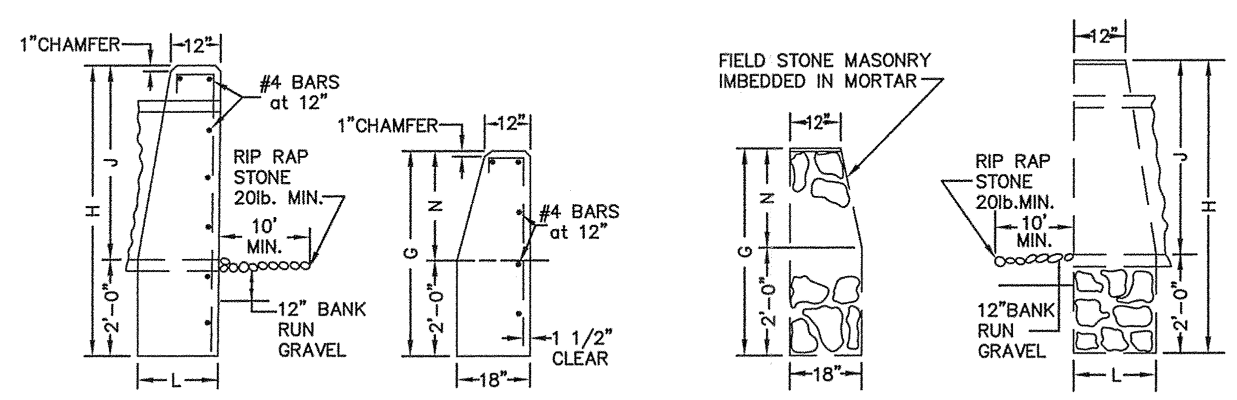




ALTER AS NEEDED TO MEET SITE CONDITIONS

D	E	F	G	H	J	L	N	P
12"	2'-6"	4'-8"	3'-2"	4'-0"	2'-0"	1'-6"	1'-2"	3'-5"
15"	2'-9"	5'-4"	3'-3"	4'-3"	2'-3"	1'-6"	1'-3"	3'-9"
18"	3'-0"	6'-4"	3'-6"	4'-6"	2'-6"	1'-6"	1'-6"	4'-1"

1.) ALL CONCRETE DIMENSIONS SHOWN ARE MINIMUM
2.) CONCRETE SHALL BE 4000 P.S.I. MINIMUM
3.) ALL REINFORCING SHALL BE #4 MINIMUM

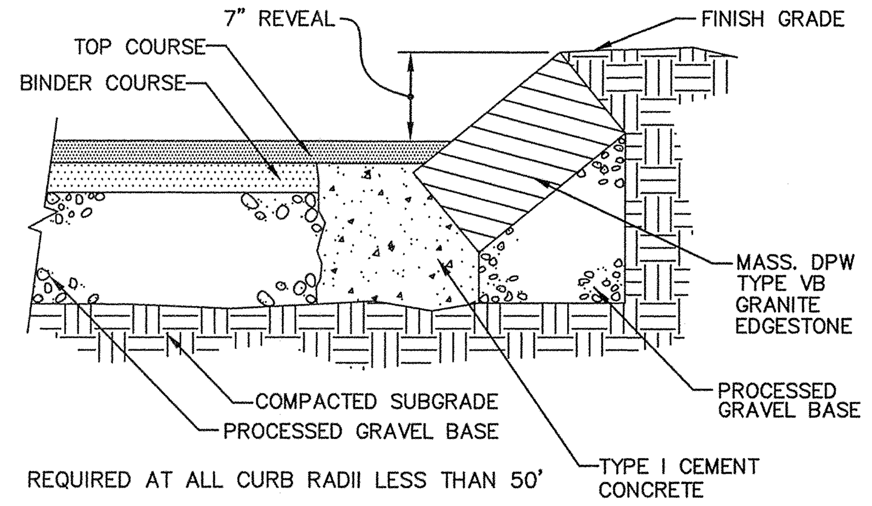


CONCRETE ENDS

FIELD STONE MASONRY ENDS

CONCRETE AND FIELDSTONE MASONARY HEADWALL \ WINGWALL DETAILS

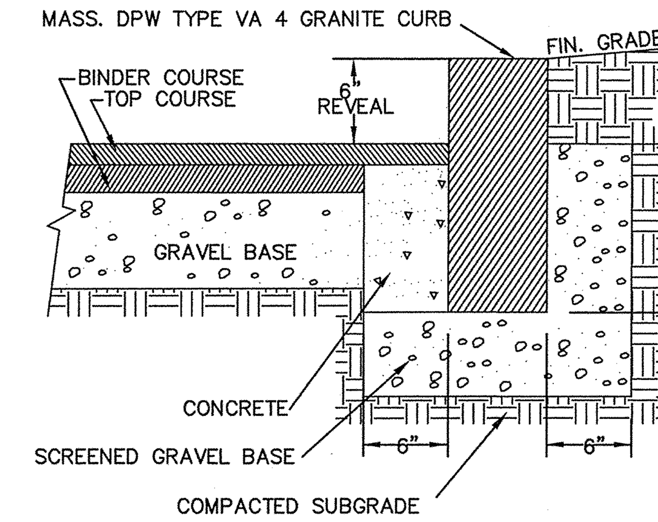
NOT TO SCALE



REQUIRED AT ALL CURB RADII LESS THAN 50'

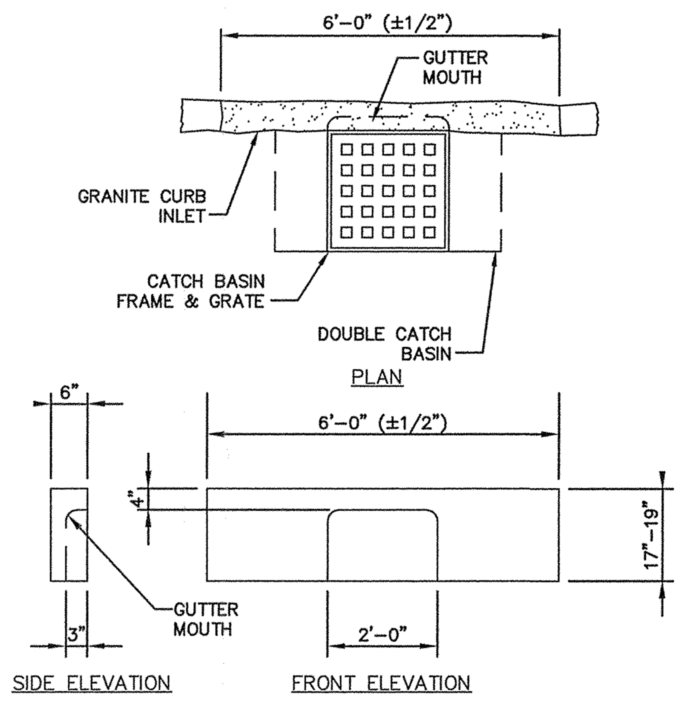
SLOPED GRANITE EDGING

NOT TO SCALE



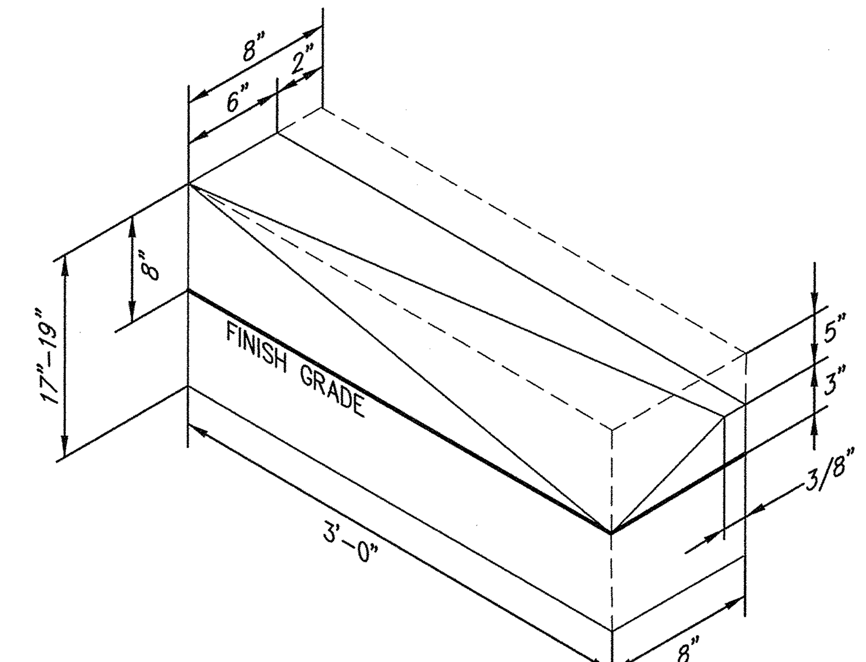
VERTICAL GRANITE CURB

NOT TO SCALE



GRANITE CURB INLET

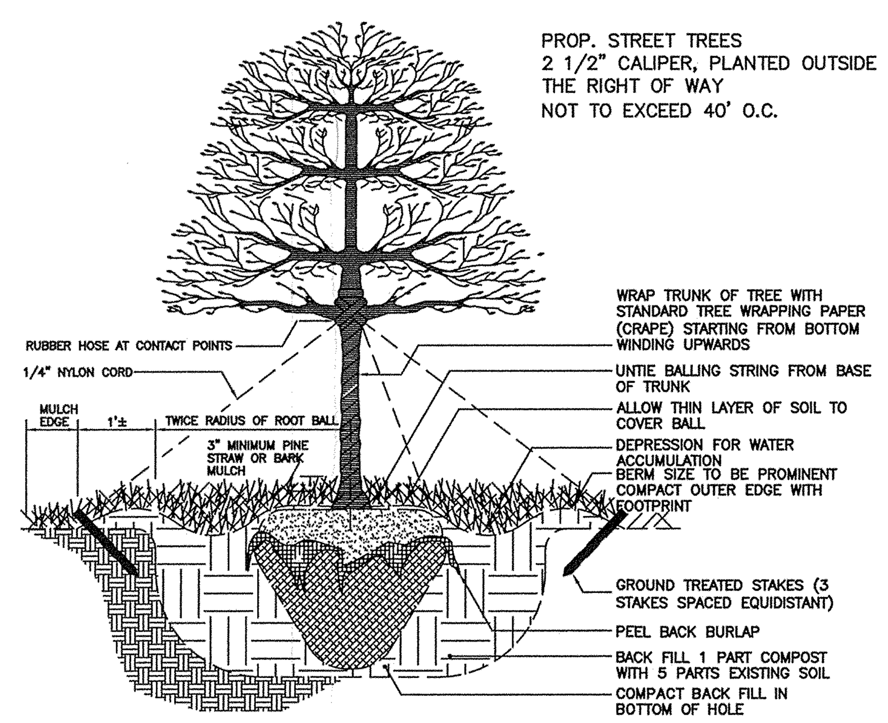
NOT TO SCALE



TRANSITION STONE

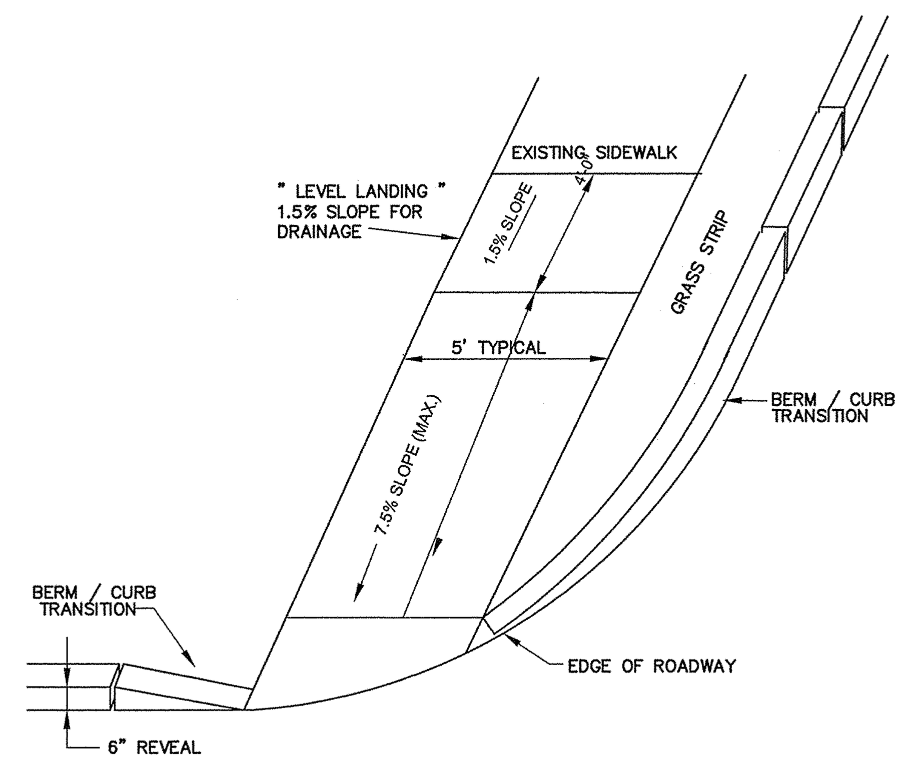
CURB INLET TO SLOPED CURB

NOT TO SCALE



STAKING AND PLANTING TREE DETAIL

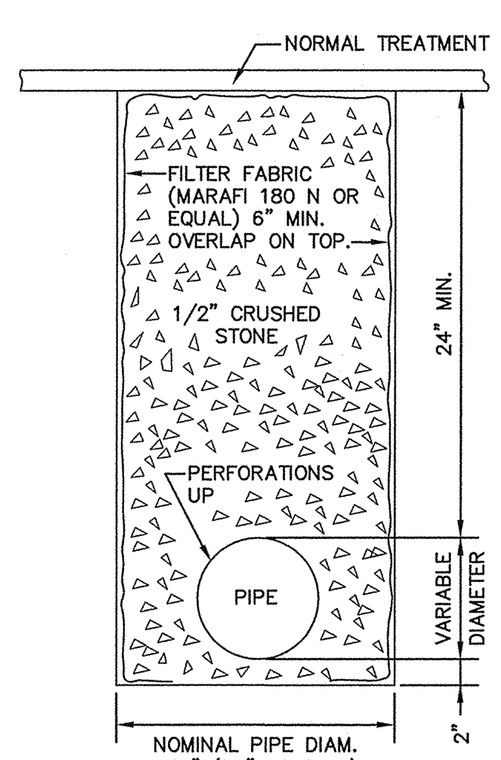
NOT TO SCALE



WHEEL CHAIR RAMP

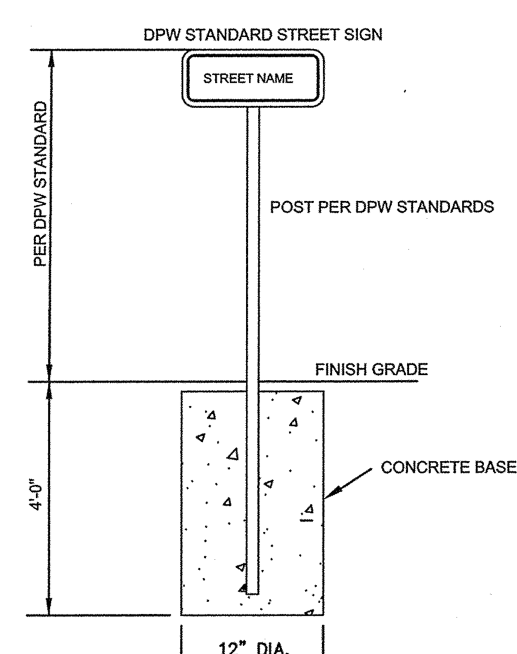
FOR SIDEWALK UP TO 8' WIDE

NOT TO SCALE



SUBDRAIN DETAILS

NOT TO SCALE

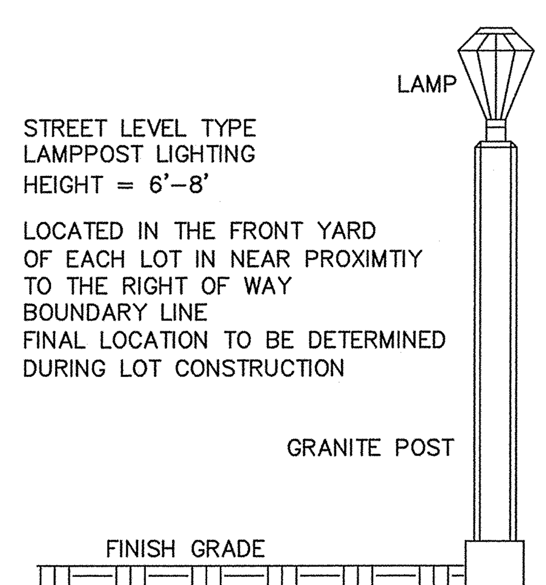


SIGN POST DETAIL

NOT TO SCALE

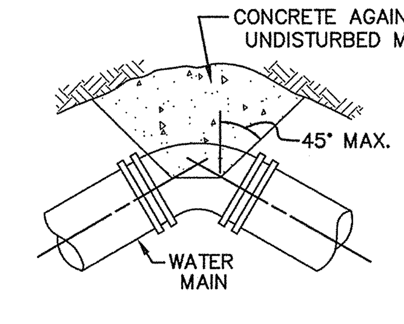
STREET LEVEL TYPE LAMPPOST LIGHTING HEIGHT = 6'-8'

LOCATED IN THE FRONT YARD OF EACH LOT IN NEAR PROXIMTIY TO THE RIGHT OF WAY BOUNDARY LINE FINAL LOCATION TO BE DETERMINED DURING LOT CONSTRUCTION

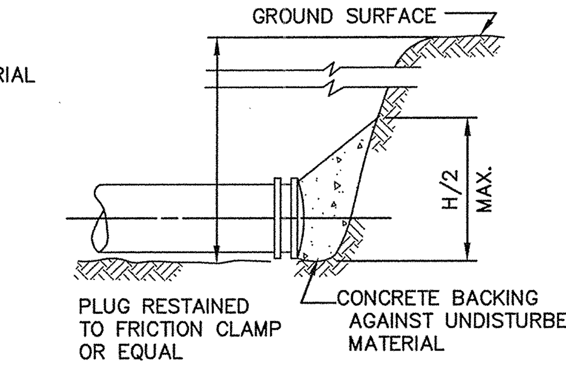


LAMP POST DETAIL

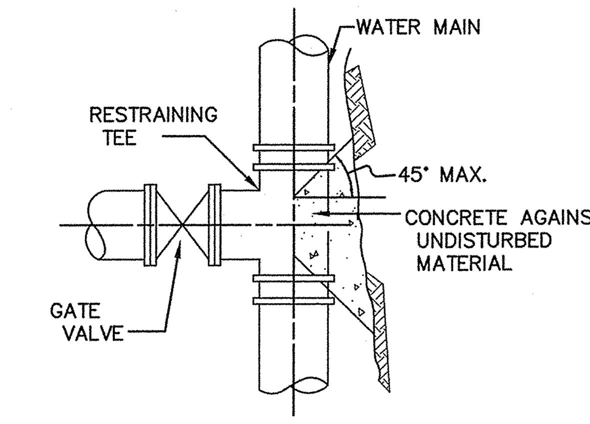
NOT TO SCALE



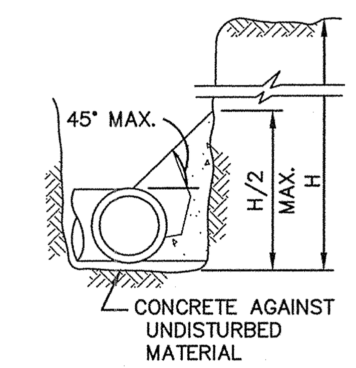
TYPICAL BEND



TYPICAL PLUG



TYPICAL TEE & VALVE



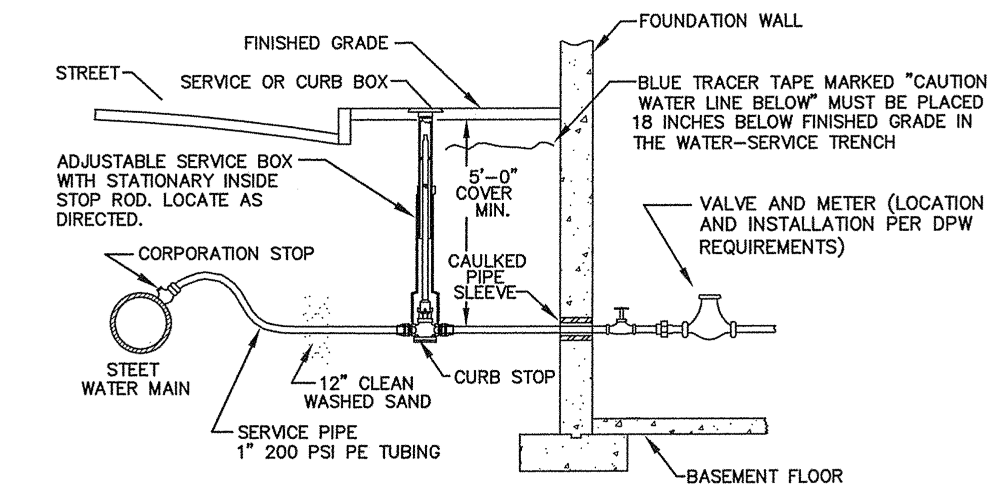
TYPICAL SECTION

NOTE: CONCRETE FOR THRUST BLOCKS SHALL BE NO LONGER THAN THE RATIO OF 2 1/2 : 5 1/2 AND SHALL HAVE A MINIMUM COMPRESSION STRENGTH OF 2000 PSI (SO THAT FLANGES AND BOLTS ARE ACCESSIBLE.)

BEARING AREAS OF THRUST BLOCKS (BEARING AREA IN SQUARE FT.)				
PIPE SIZE INCHES	1/4 BEND	1/8 BEND	1/16 BEND OR LESS	PLUG TEES
6 AND 8	8	8		8
10 AND 12	22	13	8	16

TYPICAL THRUST BLOCK DETAIL

NOT TO SCALE



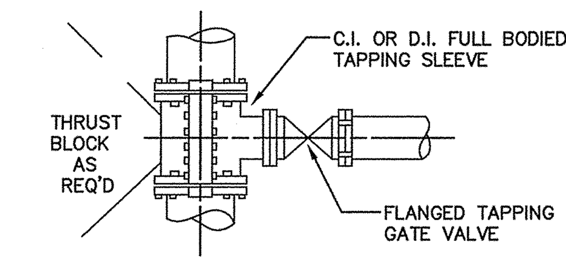
NOTES:

PLASTIC 200 PSI TUBING SHALL MEET AWWA SPEC. AND BE 200 PSI (MIN.)

ALL CONSTRUCITON METHODS AND MATERIALS INCLUDING CURB STOP, CORPORATION STOP, SERVICE PIPE, SERVICE BOX, VALVES, AND METER SHALL BE IN ACCORDANCE WITH THE TOWN OF NORTHBOROUGH DPW STANDARDS AND SPECIFICATIONS.

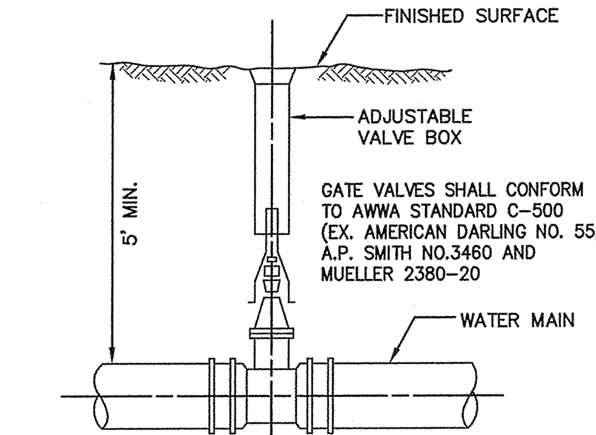
TYPICAL WATER SERVICE CONNECTION

NOT TO SCALE



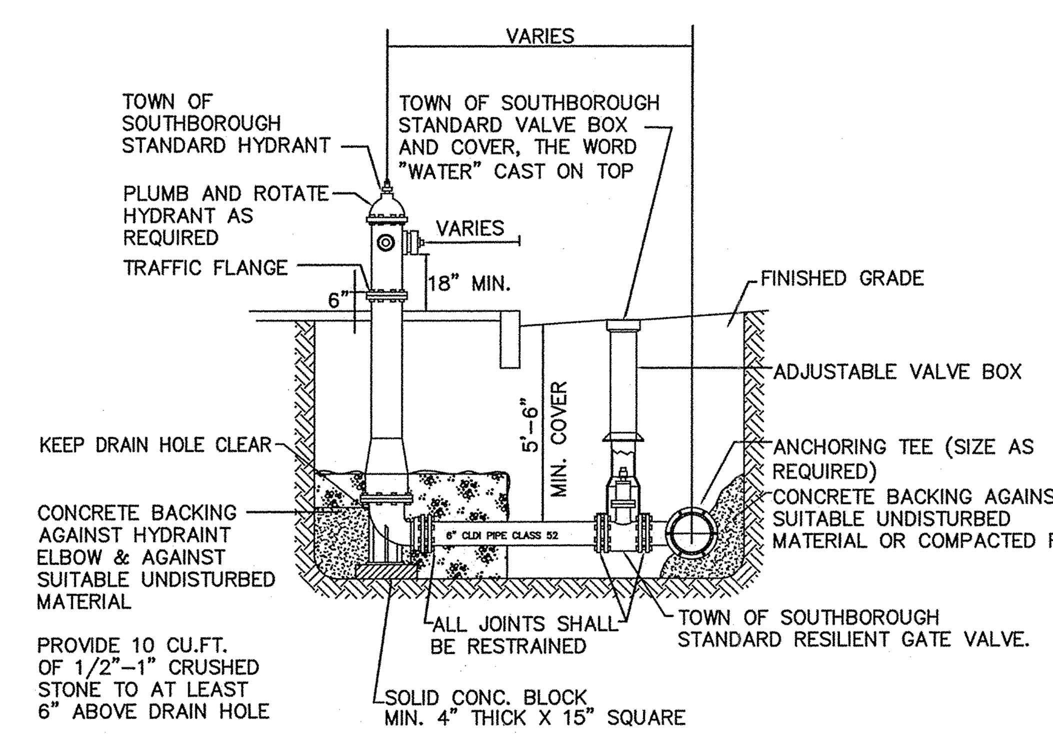
TAPPING SLEEVE AND VALVE DETAILS

NOT TO SCALE



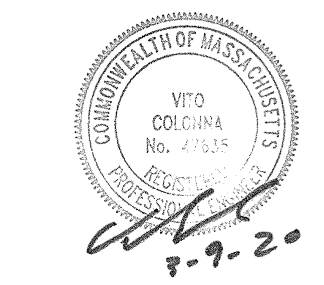
TYPICAL GATE VALVE

NOT TO SCALE



TYPICAL HYDRANT & VALVE DETAIL

NOT TO SCALE



APPROVAL UNDER THE SUBDIVISION CONTROL LAW, IS REQUIRED.

MEDWAY PLANNING AND ECONOMIC DEVELOPMENT BOARD

DATE:

THIS PLAN IS SUBJECT TO A COVENANT TO BE RECORDED HEREWITH.

I, ______________ CLERK OF THE TOWN OF MEDWAY RECEIVED AND RECORDED APPROVAL FROM THE PLANNING BOARD OF THIS PLAN ON ______________ AND NO APPEAL WAS TAKEN FOR TWENTY (20) DAYS THEREAFTER.

OWNER / APPLICANT:

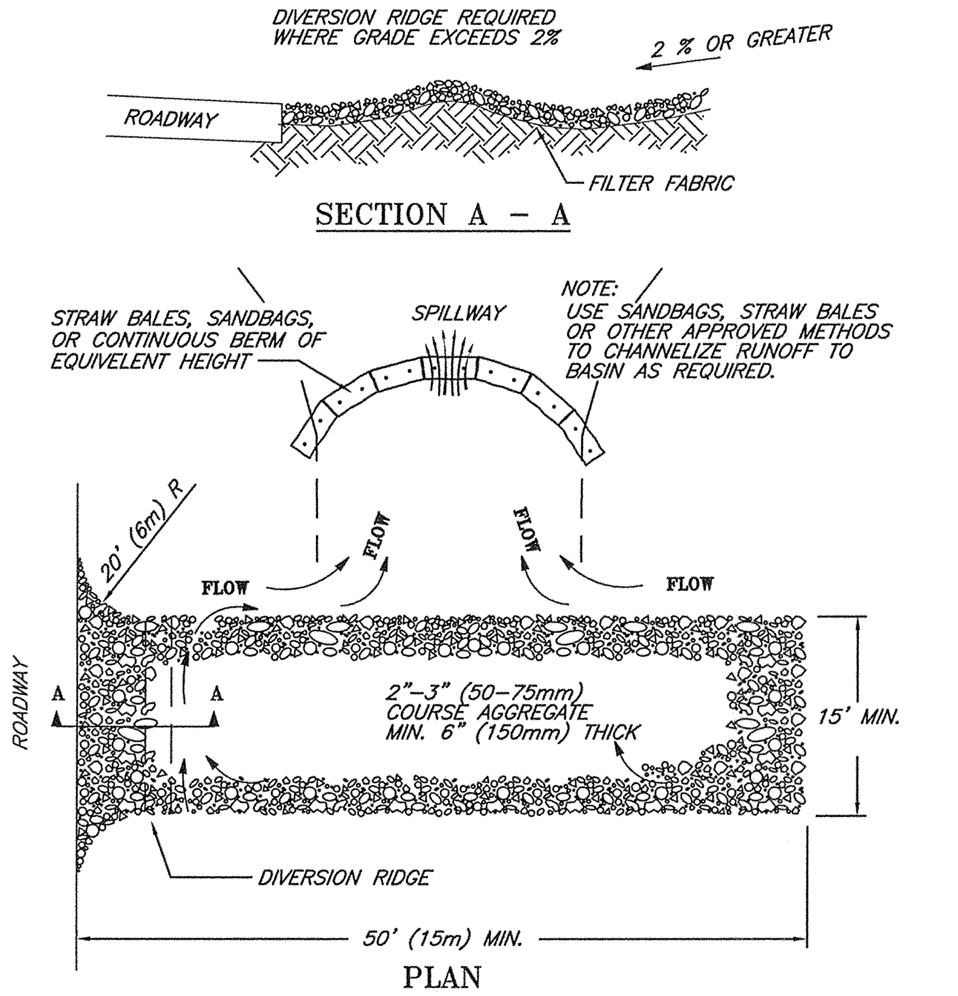
THE RESIDENCES AT CHOATE TRAIL, LLC
17 GOLDFINCH LANE
NASHUA, NH 03062

CONNORSTONE ENGINEERING INC.
CIVIL ENGINEERS AND LAND SURVEYORS
10 SOUTHWEST CUTOFF, SUITE 7
NORTHBOROUGH, MASSACHUSETTS 01532
PHONE: 508-393-9727 FAX: 508-393-5242

DEFINITIVE PLAN CONSTRUCTION DETAILS OF CHOATE TRAIL WAY IN MEDWAY, MASS

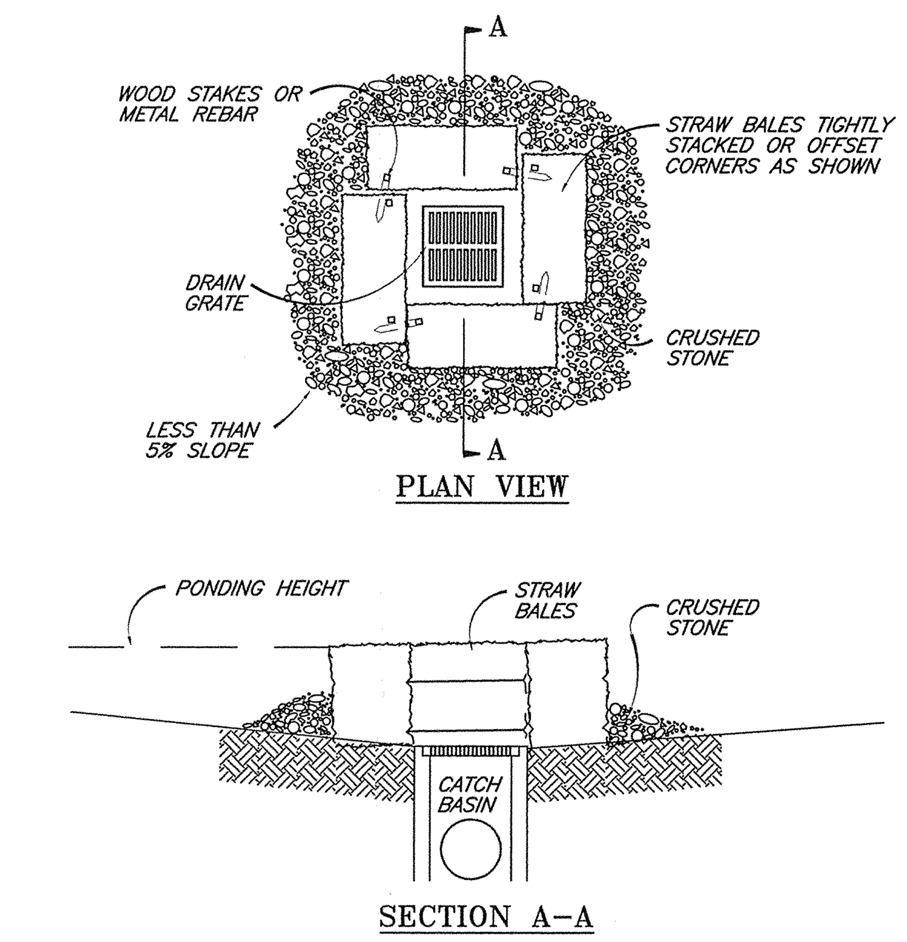
REVISED:	DESCRIPTION:
3/9/2020	REVIEW COMMENTS
1/13/2020	REVIEW COMMENTS
1/3/2020	REVIEW COMMENTS

DRAWN BY: RM | CHECK BY: VC
DATE: NOVEMBER 8, 2019
SCALE: NONE | SHEET 6 OF 7.



NOTES:
1. THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION THAT WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHT–OF–WAYS. THIS MAY REQUIRE TOP DRESSING, REPAIR AND/OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT.
2. WHEN NECESSARY, WHEELS SHALL BE CLEANED PRIOR TO ENTRANCE ONTO PUBLIC RIGHT–OF–WAY.
3. WHEN WASHING IS REQUIRED, IT SHALL BE DONE ON AN AREA STABLIZED WITH CRUSHED STONE THAT DRAINS INTO AN APPROVED SEDIMENT TRAP OR SEDIMENT BASIN.

TEMPORARY GRAVEL CONSTRUCTION ENTRANCE/EXIT



NOTES:
1. SEDIMENT BARRIERS ARE TO BE USED FOR SMALL, NEARLY LEVEL DRAINAGE AREAS. (LESS THAN 5%)

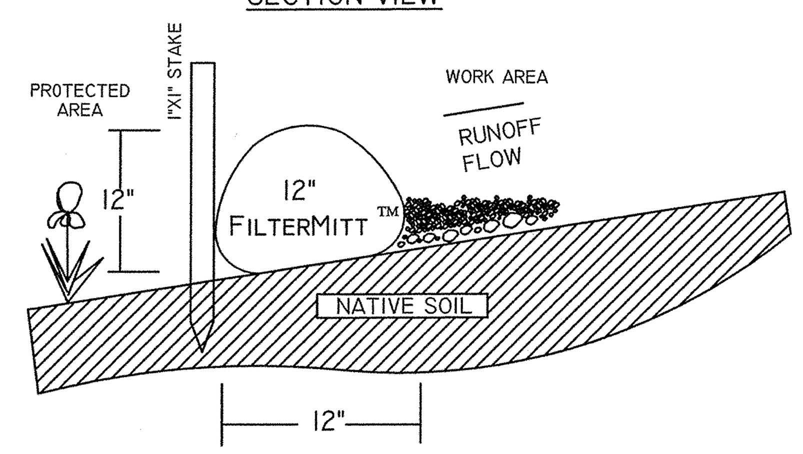
PLACE BALES WITH ENDS TIGHTLY ABUTING. STONE BACKFILL WILL PREVENT EROSION OR FLOW AROUND THE BALES.

STRAW BALE/GRAVEL SEDIMENT BARRIER AT CATCH BASINS

NOT TO SCALE

FILTERMITT™

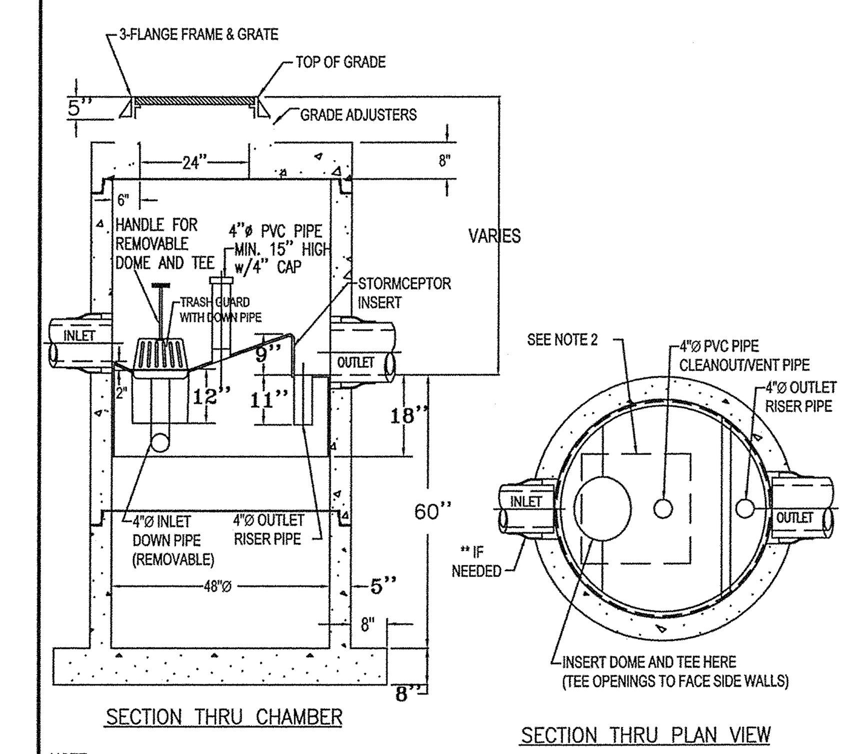
SECTION VIEW



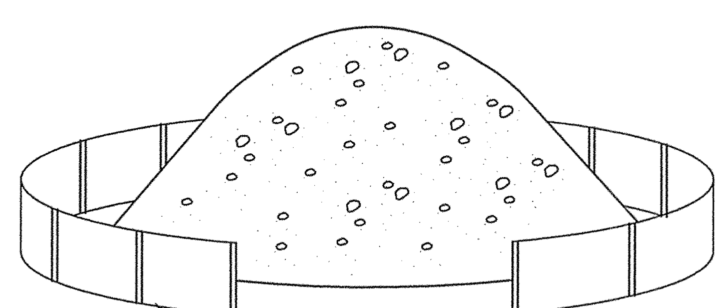
SEDIMENT BARRIER DETAIL

NOT TO SCALE

Stormceptor	Hydro Conduit	DR. BY: N. BALDWIN
	STC 450i Precast Concrete Stormceptor (450 US Gallon Capacity)	CK. BY:
		DATE: MARCH 20, 2001
	PROJECT:	SCALE: N.T.S.
	LOCATION:	DWG.#



NOTE :
1. THE USE OF FLEXIBLE CONNECTIONS IS RECOMMENDED AT THE OUTLET WHERE APPLICABLE.
2. THE COVER SHOULD BE POSITIONED OVER THE 4"ø CLEANOUT/VENT PIPE AND THE 4"ø INLET DOWN PIPE.
3. THE STORMCEPTOR SYSTEM IS PROTECTED BY ONE OR MORE OFF THE FOLLOWING U.S. PATENTS: #4985148, #5498331, #5725760, #5753115, #5849181.
4. CONTRACTOR TO PROVIDE CRANE TO SET UNIT (HEAVIEST SECTION WEIGHS 5000 LB)

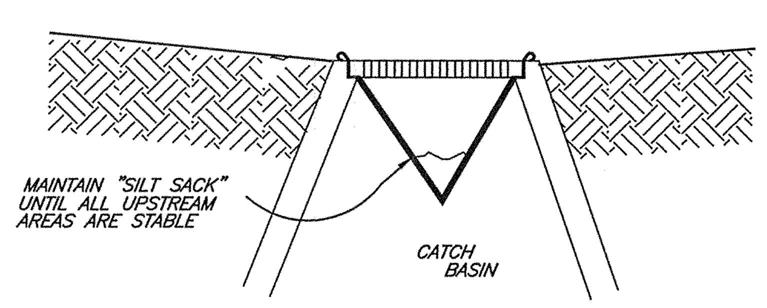


SILT FENCE LOCATED AROUND PERIMETER OF STOCKPILE. ENTRENCH 3" MINIMUM.

NOTES:
1. NO MATERIALS SUBJECT TO EROSION SHALL BE STOCKPILED OVERNIGHT WITHIN 100 FEET OF A WETLAND UNLESS COVERED.
2. STOCKPILES SHALL BE LOCATED ON DRY STABLE AREAS.
3. STOCKPILES TO REMAIN FOR GREATER THAN SEVEN DAYS SHALL BE STABILIZED WITH A TEMPORARY SEED MIXTURE.

SOIL STOCKPILE DETAIL

NOT TO SCALE



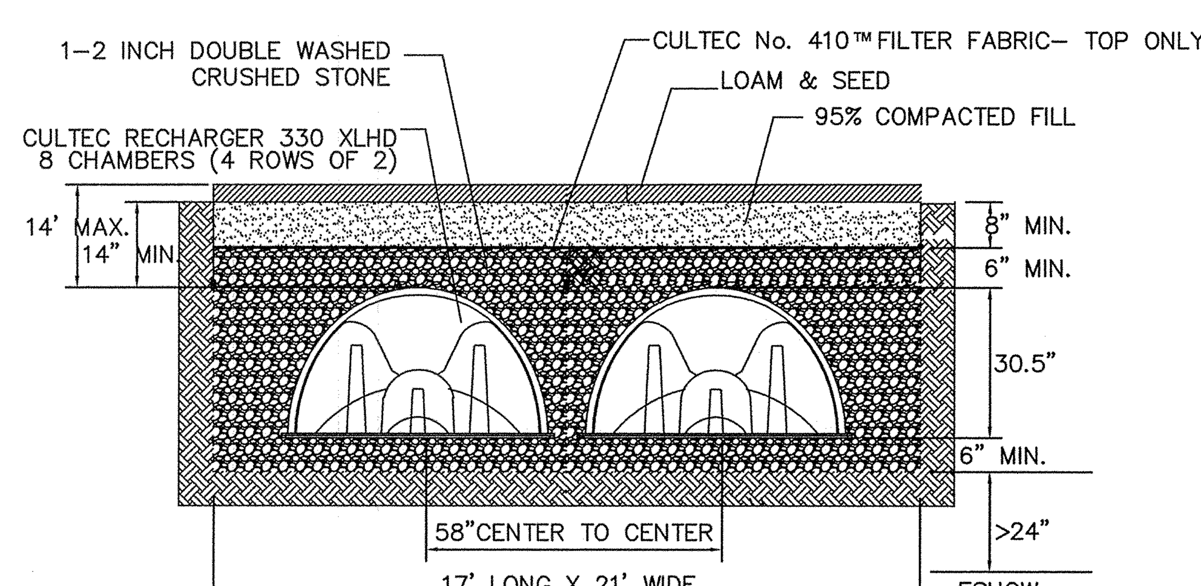
NOTES:
1. SILT SACKS ARE TO BE INSPECTED WEEKLY DURING CONSTRUCTION AND IMMEDIATELY AFTER STORM EVENTS.
2. IF SILT SACKS ARE MORE THAN 1/3RD FULL, THEY SHALL BE EMPTIED IMMEDIATELY. CAPTURED SILT SHALL BE RETAINED ON SITE AND REUSED.

SILT SACK OR EQUAL SEDIMENT CONTAINMENT SYSTEM

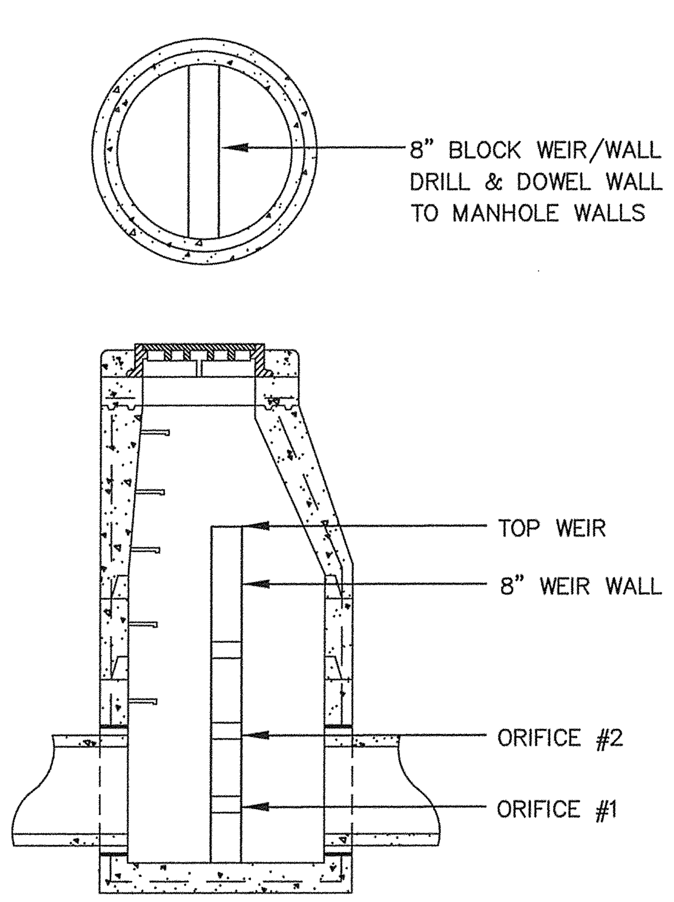
NOT TO SCALE

NOTE: DRYWELLS CONSIST OF 8 CULTEC 330XLHD CHAMBERS WITH CAPACITY FOR A ROOF AREA OF 3,200 SQUARE FEET. FINAL DESIGN OF HOUSES SHALL PROVIDE FOR AT LEAST ONE CHAMBER PER 400 SQUARE FEET OF ROOF AREA.

NOTE: REMOVE TOP/SUBSOIL BELOW DRYWELL TO THE "C1" LAYER. ANY FILL REQUIRED BELOW THE BOTTOM OF STONE SHALL BE FREE–DRAINING CLEAN SAND PER TOWN REQUIREMENTS.



CULTEC RECHARGER 330 XLHD CHAMBER SYSTEM TYPICAL CROSS SECTION DETAIL



OUTLET CONTROL STUCTURE WEIR WALL DETAIL

NOT TO SCALE

I, ______________ CLERK OF THE TOWN OF MEDWAY RECEIVED AND RECORDED APPROVAL FROM THE PLANNING BOARD OF THIS PLAN ON ____________ AND NO APPEAL WAS TAKEN FOR TWENTY (20) DAYS THEREAFTER.

APPROVAL UNDER THE SUBDIVISION CONTROL LAW, IS REQUIRED.
MEDWAY PLANNING AND ECONOMIC DEVELOPMENT BOARD

DATE: ____________

THIS PLAN IS SUBJECT TO A COVENANT TO BE RECORDED HEREWITH.

COMMONWEALTH OF MASSACHUSETTS VITO COLONNA No. 47635 CIVIL REGISTERED PROFESSIONAL ENGINEER

3-9-20

OWNER / APPLICANT:
THE RESIDENCES AT CHOATE TRAIL, LLC
17 GOLDFINCH LANE
NASHUA, NH 03062

CONNORSTONE ENGINEERING INC.
CIVIL ENGINEERS AND LAND SURVEYORS
10 SOUTHWEST CUTOFF, SUITE 7
NORTHBOROUGH, MASSACHUSETTS 01532
PHONE: 508-393-9727 FAX: 508-393-5242

DEFINITIVE PLAN
CONSTRUCTION DETAILS
OF
CHOATE TRAIL WAY
IN
MEDWAY, MASS

REVISED:	DESCRIPTION:
3/9/2020	REVIEW COMMENTS
1/13/2020	REVIEW COMMENTS
1/3/2020	REVIEW COMMENTS

DRAWN BY: RM | CHECK BY: VC
DATE: NOVEMBER 8, 2019
SCALE: NONE | SHEET 7 OF 7.

December 10, 2019
(revised January 23, 2020)
(revised March 26, 2020)

Ms. Susan E. Affleck-Childs
Medway Planning and Economic Development Coordinator
Medway Town Hall
155 Village Street
Medway, MA 02053

Re: 42 Highland Street (Choate Trail Way)
Definitive Subdivision Review (Permanent Private Way)
Medway, Massachusetts

Dear Ms. Affleck-Childs:

Tetra Tech (TT) has performed a review of the proposed Site Plan for the above-mentioned Project at the request of the Town of Medway Planning and Economic Development Board (PEDB). The proposed Project is located at 42 Highland Street in Medway, MA. Proposed Project includes the development of a 4-lot residential subdivision, appurtenant roadway, utilities, and stormwater drain infrastructure.

TT is in receipt of the following materials:

- A plan set (Plans) titled "Definitive Subdivision Plan, Choate Trail Way in Medway, Mass.", dated November 8, 2019, prepared by Connorstone Engineering, Inc (CEI).
- An Application for Approval of a Definitive Subdivision Plan, dated October 15, 2019.
- A stormwater report (Report) titled "Stormwater Report for Choate Trail Way Off Highland Street, Medway, MA" dated November 8, 2019, prepared by CEI.
- A Stormwater Pollution Prevention Plan (SWPPP) prepared by CEI.
- NRCS Soil Mapping and Test Pit Results prepared by CEI.

The Plans and accompanying materials were reviewed for conformance with Chapter 100 of the Town of Medway PEDB Rules and Regulations (Regulations) and good engineering practice. Review of the project for zoning, stormwater and wetland related issues was not completed as these reviews are conducted by other consultants/town permitting authorities.

TT 1/23/2020 Update

The Applicant has supplied TT with a revised submission addressing comments provided in our previous letter including the following documents:

- A plan (Plans) set titled "Definitive Subdivision Plan, Land Plan, Choate Trail Way in Medway, Mass." dated November 8, 2019, revised January 13, 2020, prepared by CEI.
- A Response to Comments letter with waivers dated January 14, 2020, prepared by CEI.

The revised Plans and supporting information were reviewed against our previous comment letter (December 10, 2019) and comments have been tracked accordingly. Text shown in gray represents information contained in previous correspondence while new information is shown in black text.

TT 3/26/2020 Update

The Applicant has supplied TT with a revised submission addressing comments provided in our previous letter including the following documents:

- A plan (Plans) set titled "Definitive Subdivision Plan, Land Plan, Choate Trail Way in Medway, Mass." dated November 8, 2019, revised March 9, 2020, prepared by CEI.
- A Response Letter dated March 9, 2020, prepared by CEI.

The revised Plans and supporting information were reviewed against our previous comment letter (January 23, 2020) and comments have been tracked accordingly. Text shown in gray represents information contained in previous correspondence while new information is shown in black text.

DEFINITIVE SUBDIVISION REVIEW

1. The Applicant has not supplied a Development Impact Report. (Ch. 100 Section 5.5.11)
   - *CEI 1/14/2020 Response: The DIR was attached in the original application package.*
     - TT 1/23/2020 Update: In our opinion, this item has been resolved.
2. The Applicant has not supplied the required ANRAD determination from the Medway Conservation Commission (Conservation). (Ch. 100 Section 5.5.14)
   - *CEI 1/14/2020 Response: The applicant has submitted a Notice of Intent and Stormwater Application with the Conservation Commission to review the project.*
     - TT 1/23/2020 Update: No action necessary until Conservation Commission review is complete.
3. A Certified List of Abutters within seven hundred feet (700') of the boundaries of the land shown in the subdivision has not been provided. (Ch. 100 Section 5.7.5)
   - *CEI 1/14/2020 Response: The required Certified List of Abutters was included with the application. Section 5.7.5 required showing abutters as listed on Form E, which is specifically defined as abutters within 300 feet, and then all other land within 700 feet. This information is shown on the project locus map.*
     - TT 1/23/2020 Update: In our opinion, this item has been resolved.
4. Applicant has not provided zoning district information that falls within the locus of the plan. Zoning districts AR-I and AR-II are present along Highland Street, please add zoning districts if visible within the locus limit. (Ch. 100 Section 5.7.13)
   - *CEI 1/14/2020 Response: The zoning district boundary is located to the south of Highland Street and has been added to the locus map.*
     - TT 1/23/2020 Update: In our opinion, this item has been resolved.
5. The Applicant has not provided a cover sheet for the project with the required waiver requests shown. (Ch. 100 Section 5.7.16)
   - *CEI 1/14/2020 Response: The requested list of waivers has been added to the cover sheet.*
     - TT 1/23/2020 Update: In our opinion, this item has been resolved.

6. The Board signature block shall be titled “Planning and Economic Development Board”. (Ch. 100 Section 5.7.18)

- *CEI 1/14/2020 Response: The signature block has been updated as noted.*
    - TT 1/23/2020 Update: In our opinion, this item has been resolved.

7. Provisions for street lighting have not been proposed. (Ch. 100 Section 5.7.28)

- *CEI 1/14/2020 Response: The proposed street lighting has been added to the plans to include one light at the intersection and the individual post lights.*
    - TT 1/23/2020 Update: It appears the proposed light pole is located behind the proposed signage which may screen the signs from being seen by vehicles exiting the development. Additionally, we recommend the Applicant provide type of light fixtures proposed throughout the subdivision and expected photometrics plan showing light dispersal.
        - *CEI 3/9/2020 Response: No response.*
            - TT 3/26/2020 Update: This item not specifically addressed by the Applicant in the Response Letter. However, lamp posts have been placed at driveway entrances consistent with discussions throughout the public hearing process. Photometric plan has not been submitted but we do not anticipate light trespass from the proposed lamp posts. In our opinion, this item has been resolved.

8. Proposed driveways have not been shown on the Plans. (Ch. 100 Section 5.7.30)

- *CEI 1/14/2020 Response: The proposed driveways and aprons have been provided on the plans.*
    - TT 1/23/2020 Update: In our opinion, this item has been resolved.

9. The project will meet the threshold of the Town of Medway Article XXVI - Stormwater Management and Land Disturbance Bylaw and will be required to address items listed in the Subdivision Regulations under the Bylaw. (Ch. 100 Section 7.3.1)

- *CEI 1/14/2020 Response: A Stormwater Application has been filed with the Conservation Commission.*
    - TT 1/23/2020 Update: No action necessary until Conservation Commission review is complete.

10. The proposed water main is located under the landscaped island which is prohibited. (Ch. 100 Section 7.6.2)

- *CEI 1/14/2020 Response: The proposed water main has been updated to route around the island.*
    - TT 1/23/2020 Update: In our opinion, this item has been resolved.

11. Notes shall be added to the Plans which ensure that no dwelling units can be constructed without first coordinating with the Medway Board of Health for the proposed septic systems. (Ch. 100 Section 7.6.2.e)

- *CEI 1/14/2020 Response: A note has been provided on sheet 3, and an additional note has been added on sheet 2.*

- TT 1/23/2020 Update: In our opinion, this item has been resolved.

12. Utility poles are located on the opposite side of Highland Street and will require trenching and installation of the crossing of Highland Street below grade. The Plans shall specifically note that all electric/tel/data shall be installed underground including connections to existing utility poles. (Ch. 100 Section 7.6.2.g)

    - *CEI 1/14/2020 Response: The initial feedback from the utility company would be to locate a pole on the locus property and the once on-site drop to underground service.*
        - TT 1/23/2020 Update: We do not recommend this approach as it provides additional overhead crossing of Highland Street. All services must be located underground per required PEDB regulations. Additionally, the proposed utility pole is located on private property and may also impact sight lines for vehicles exiting the development.
            - *CEI 3/9/2020 Response: No response.*
                - TT 3/26/2020 Update: This item not specifically addressed by the Applicant in the Response Letter. A note has been placed on Sheet 3 of 7 describing overhead wires from pole to pole within the Highland Street right of way, however we recommend the Applicant modify the note pointing to the elec/tel/cable/spare lines within the subdivision specifically calling out wires to be located underground. We recommend the PEDB Condition this item in the Decision for the Project.

13. The Applicant has not proposed a spare conduit for the proposed electric/tel/data installation. (Ch. 100 Section 7.6.2.h)

    - *CEI 1/14/2020 Response: A spare conduit has been added on the typical cross section.*
        - TT 1/23/2020 Update: In our opinion, this item has been resolved.

14. The proposed project is creating four lots, the Regulations state a maximum of three lots shall be permitted for permanent private ways. (Ch. 100 Section 7.9.1.e)

    - *CEI 1/14/2020 Response: The project had been designed in accordance with the Neighborhood Street Standards, which allows up to five (5) lots.*
        - TT 1/23/2020 Update: In our opinion, this item has been resolved.

15. The Applicant has not supplied curb radii at roadway intersection with Highland Street. (Ch. 100 Section 7.9.2.d)

    - *CEI 1/14/2020 Response: The proposed curb radii has been labeled at the intersection.*
        - TT 1/23/2020 Update: In our opinion, this item has been resolved.

16. A level slope area is required for the first 100-feet of roadway. The proposed roadway changes grade within the first 100-feet. (Ch. 100 Section 7.9.5.c)

    - *CEI 1/14/2020 Response: A waiver has been requested to allow a vertical curve within the leveling area. This curve transitions from a -2% slope to a #2% slope so the maximum grade will be over 2%. This curve is required to minimize earthwork, land disturbance, and fill requirements.*
        - TT 1/23/2020 Update: No action necessary until PEDB decision on Waivers.

17. The Applicant has not provided curb along the entire length of the roadway. Curb is shown in the plan view at the radii along the roadway alignment but does not appear to be included in the tangent sections. (Ch. 100 Section 7.10.2)

   - *CEI 1/14/2020 Response: Sloped granite curbing was proposed throughout the subdivision except at the intersection with Highland Street and cul-de-sac entrance roundings. Additional notes have been added for clarify.*

     - TT 1/23/2020 Update: In our opinion, this item has been resolved.

18. The driveway apron for Lot 4 is proposed within 14 feet of a catch basin. (Ch. 100 Section 7.11.2)

   - *CEI 1/14/2020 Response: The driveway apron has been adjusted to provide the required 14 feet.*

     - TT 1/23/2020 Update: In our opinion, this item has been resolved.

19. Proposed sidewalk ends at the intersection of Highland Street and does not extend across the frontage of Lot 1 and Lot 4. (Ch. 100 Section 7.13.3)

   - *CEI 1/14/2020 Response: A waiver has been requested from this requirement.*

     - TT 1/23/2020 Update: No action necessary until PEDB decision on Waivers.

20. The Applicant has not proposed street lighting and should coordinate with Medway Public Safety Officer to determine if they are required. (Ch. 100 Section 7.21)

   - *CEI 1/14/2020 Response: Street lighting has been provided through a light at the intersection and individual post lights.*

     - TT 1/23/2020 Update: See TT Update at item 7.

       - *CEI 3/9/2020 Response: No response.*

         - TT 3/26/2020 Update: See TT Update at Item 7.

GENERAL COMMENTS

21. The applicant is proposing a dead-end water line at the end of the cul-de-sac. Applicant or design engineer should coordinate with Medway Department of Public Services to show that enough flow will exist to maintain water quality and adequate fire protection at the dead-end hydrant.

   - *CEI 1/14/2020 Response: The DPW has been contacted and plans provided. Feedback or comment have not been received, but any input provided by DPW would be incorporated into the plans.*

     - TT 1/23/2020 Update: No action necessary until Medway DPW returns comments/recommendations.

22. The Applicant shall confirm with Medway DPW if proposed tapping sleeve is an acceptable connection to the existing water main in Highland Street. In past projects a valve tree has been required at all new connections.

   - *CEI 1/14/2020 Response: The DPW has been contacted and plans provided. Feedback or comment have not been received, but any input provided by DPW would be incorporated into the plans.*

- TT 1/23/2020 Update: No action necessary until Medway DPW returns comments/recommendations.

23. The Applicant shall coordinate with the Medway Public Safety Officer to determine if a painted "STOP" and stop line are required to be proposed.
    - *CEI 1/14/2020 Response: A painted "STOP" and stop line has been added to the plans.*
        - TT 1/23/2020 Update: In our opinion, this item has been resolved.
24. Sheet 4 of the Plans shows 4 dashed polygons within the proposed roadway that do not have any description. If the polygons are proposed inlet protection, please relocate to show the polygons over the proposed catch basins.
    - *CEI 1/14/2020 Response: The inlet protection symbols have been adjusted.*
        - TT 1/23/2020 Update: In our opinion, this item has been resolved.

These comments are offered as guides for use during the Town's review and additional comments may be generated during the course of review. The applicant shall be advised that any absence of comment shall not relieve him/her of the responsibility to comply with all applicable local, state and federal regulations for the Project. If you have any questions or comments, please feel free to contact us at (508) 786-2200.

Very truly yours,

Steven Bouley

Steven M. Bouley, P.E.
Senior Project Engineer

Bradley Picard

Bradley M. Picard, E.I.T.
Civil Engineer

P:\21583\143-21583-20008 (PEDB 42 HIGHLAND ST)\DOCS\42HIGHLAND-PEDBREV(2020-03-26).DOCX

PGC ASSOCIATES, LLC
1 Toni Lane
Franklin, MA 02038-2648
508.533.8106
gino@pgcassociates.com

March 31, 2020

Mr. Andy Rodenhiser, Chairman
Medway Planning Board
155 Village Street
Medway, MA 02053

RE: Choate Trail Definitive Subdivision Plan

Dear Mr. Rodenhiser:

I have reviewed the revised definitive plan submitted by owner/applicant Lock it Up, LLC of Newton. The proposed work is to construct a neighborhood street in the form of cul-de-sac with 4 lots. The plan was prepared by Connorstone Engineering, Inc. of Northborough of and is dated November 8, 2019 with revision dates of January 3 and 13, and March 9,2020. I have repeated the comments from my December 4, 2019 letter and comments from my January 23 letter in **bold** as with new comments in italics follows:

1. The proposed lots comply with zoning for area, frontage, and lot shape factor. The lots also appear to meet the 50% upland requirement, but a calculation should be done for Lot 1 to document this. **The calculation has now been added to the plans.** *OK*

2. The intersection with Highland Street is offset more than 150 feet from the Highland Street intersection with Summer Street. **OK**

3. Section 5.7.6 requires the Existing Conditions sheet to locate trees with a diameter greater than 12 inches. This was not done. **This has now been done.** *OK*

4. Section 5.7.15 requires easements on the subject parcel and abutting land as well as their purpose. A 20' wide right-of-way is shown on three abutting lots, but the purpose is not clear. **The purpose of the right-of-way is still not clear, but the applicant is continuing to research it.** *This is still not clear but applicant is now providing an access easement as part of the subdivision to access public land.*

5. Section 7.9.6 (c) requires that subdivisions provide an extension to abutting undeveloped land. The Town of Medway owns the abutting land so a roadway extension is not necessary but a pedestrian extension to provide access to Choate Park should be considered. No such pedestrian path is shown on the plan. Understanding that the road is to remain private, a private easement and connection to Choate Trail for the residents of the subdivision could still be desirable. **The applicant states that he would prefer not to provide such an easement. At a minimum, the right-of-way on adjacent property that terminates at the rear of Lot 4 should be extended across the corner of Lot 4 to the Town property.** *The applicant is now providing an access easement to Choate Park.*

6. Section 5.7.16 requires waiver requests to be listed on the cover page. This was not done. **The waivers have now been added to the cover sheet.** *OK*

7. Section 5.7.28 requires existing and proposed streetlight locations to be shown This was not done. Section 7.21.1 requires streetlights at intersections and other places where the Traffic Safety Officer deems they are needed (end of cul-de-sac?). Section 7.21.7 encourages applicants to include individual post lights. **The applicant now proposes a streetlight at the intersection and post lights on the subdivision lots.** *OK*

8. Section 5.11 requires subdivisions with frontage on scenic roads to comply with Scenic Road regulations. This appears to be the case, but a public hearing is required (which could be simultaneous with the subdivision hearing. **An application for a Scenic Road Act hearing has now been submitted. The stone wall in front of the property is minimal and there is little to no stone wall visible on abutting properties. The applicant proposes to save and reuse the removed stones to construct curved walls to highlight the entrance.** *OK*

9. Section 7.13.3 requires sidewalks along the frontage of existing Town ways as well as within the subdivision. No sidewalk is proposed along the Highland Street frontage. **The applicant has applied for a waiver of this requirement. There is a sidewalk on Summer Street to connect to a short distance away. However, such a sidewalk would require tree removal and significant grading.** *OK*

10. Section 7.22 notes the Board policy of maximizing opportunities for pedestrian connections and that the Board has the discretion to require easements across lots within the subdivision to connect the subdivision to nearby schools, playgrounds, parks, or other areas (See Comment #5). Section 7.24.3 specifies that such easements shall be at least 20 feet wide. *The applicant is providing a 15-foot wide access easement, which appears to be adequate.*

If there are any questions about these comments, please call or e-mail me.

Sincerely,

Gino D. Carlucci, Jr.

LEGEND

DRAIN MAN HOLE		UTILITY POLE & GUY WIRE	
DRAINAGE LINE		CHAIN LINK FENCE	
CATCH BASIN		LIGHTPOST	
SEWER LINE		HANDICAP SPACE	
SEWER MAN HOLE		ELECTRIC TRANSFORMER	
BITUMINOUS CURBING		SIGN	
EDGE OF PAVEMENT		VERTICAL BENCHMARK	
GUARD RAIL		TREELINE	
APPROX. WATERLINE		SPOT GRADE	
HYDRANT		WETLAND LINE	
WATERGATE		TELEPHONE MAN HOLE	
APPROX. GAS LINE		MAPLE TREE >12"	
GAS GATE		PINE TREE >12"	
		OAK TREE >12"	
		DECIDUOUS TREE >12"	

MONUMENTS

SBDH Fnd.	STONE BOUND W. DRILL HOLE FOUND
CBDH Fnd.	CONCRETE BOUND W DRILL HOLE FOUND
IP Fnd.	IRON PIPE FOUND
IR Fnd.	IRON ROD FOUND

ROAD

D-1 (11/7/19)		EL.=255.5
0-8"	Ap	SANDY LOAM 10YR3/2
8-28"	Bw	LOAMY SAND 10YR5/8
28-62"	C1	LOAMY SAND 2.5Y5/6
MOTTLES AT 36" REFUSAL AT 62"		

D-3 (11/7/19)		EL.=256.0
0-10"	Ap	SANDY LOAM 10YR3/2
10-28"	Bw	LOAMY SAND 10YR5/8
28-82"	C1	LOAMY SAND 2.5Y5/4
MOTTLES AT 42"		

D-2 (11/7/19)		EL.=254.6
0-8"	Ap	SANDY LOAM 10YR3/2
8-30"	Bw	LOAMY SAND 10YR5/8
30-70"	C1	LOAMY SAND 2.5Y5/6
70-88"	C2	SANDY LOAM 2.5Y5/6
MOTTLES AT 26" WATER AT 72"		

D-4 (11/7/19)		EL.=254.0
0-8"	Ap	SANDY LOAM 10YR3/2
8-30"	Bw	LOAMY SAND 10YR5/8
30-82"	C1	LOAMY SAND 2.5Y5/4
MOTTLES AT 18" WATER AT 64"		

LOT 1

DTH-1 (7/8/19)		
0-9"	Ap	SANDY LOAM 10YR3/2
9-35"	Bw	LOAMY SAND 10YR6/8
35-57"	C1	LOAMY SAND 10YR6/4
57-122"	C2	SANDY LOAM 2.5Y5/4
MOTTLES AT 47" NO REFUSAL		

DTH-2 (7/8/19)		
0-17"		FILL
17-35"	Bw	LOAMY SAND 10YR6/8
35-56"	C1	LOAMY SAND 10YR6/4
56-97"	C2	SANDY LOAM 2.5Y5/4
MOTTLES AT 46" REFUSAL AT 97"		

DTH-3 (7/8/19)		
0-9"		FILL
9-23"	Bw	LOAMY SAND 10YR6/8
23-92"	C1	SANDY LOAM 2.5Y5/4
MOTTLES AT 45" REFUSAL AT 92"		

DTH-4 (7/8/19)		
0-10"	Ap	SANDY LOAM 10YR3/2
10-20"	Bw	LOAMY SAND 10YR6/8
20-44"	C1	LOAMY SAND 10YR6/4
44-113"	C2	SANDY LOAM 2.5Y5/4
MOTTLES AT 37" NO REFUSAL		

PT-A (7/8/19)	DEPTH 66" 6 MPI

PT-B (7/8/19)	DEPTH 52" 4 MPI

LOT 2

DTH-9 (7/8/19)		
0-6"	Ap	SANDY LOAM 10YR3/2
6-32"	Bw	LOAMY SAND 10YR6/8
32-112"	C1	LOAMY SAND 2.5Y5/4
MOTTLES AT 94" NO REFUSAL		

DTH-10 (7/8/19)		
0-6"	Ap	SANDY LOAM 10YR3/2
6-32"	Bw	LOAMY SAND 10YR6/8
32-109"	C1	LOAMY SAND 2.5Y5/4
MOTTLES AT 84" NO REFUSAL		

DTH-11 (7/8/19)		
0-6"	Ap	SANDY LOAM 10YR3/2
6-24"	Bw	LOAMY SAND 10YR6/8
24-93"	C1	SANDY LOAM 2.5Y5/4
MOTTLES AT 84" NO REFUSAL		

DTH-12 (7/8/19)		
0-5"	Ap	SANDY LOAM 10YR3/2
5-31"	Bw	LOAMY SAND 10YR6/8
31-88"	C1	LOAMY SAND 2.5Y5/4
NO MOTTLES OR WATER REFUSAL AT 88"		

PT-F (7/8/19)	DEPTH 66" 6 MPI

PT-G (7/8/19)	DEPTH 48" 6 MPI

LOT 3

DTH-13 (7/8/19)		
0-5"	Ap	SANDY LOAM 10YR3/2
5-30"	Bw	LOAMY SAND 10YR6/8
30-100"	C1	LOAMY SAND 2.5Y5/4
NO MOTTLES OR WATER REFUSAL AT 100"		

DTH-14 (7/8/19)		
0-6"	Ap	SANDY LOAM 10YR3/2
6-35"	Bw	LOAMY SAND 10YR6/8
35-105"	C1	LOAMY SAND 2.5Y5/4
NO MOTTLES OR WATER REFUSAL AT 105"		

DTH-15 (7/8/19)		
0-6"	Ap	SANDY LOAM 10YR3/2
6-35"	Bw	LOAMY SAND 10YR6/8
35-104"	C1	LOAMY SAND 2.5Y5/4
NO MOTTLES OR WATER REFUSAL AT 104"		

DTH-16 (7/8/19)		
0-6"	Ap	SANDY LOAM 10YR3/2
6-27"	Bw	LOAMY SAND 10YR6/8
27-81"	C1	LOAMY SAND 2.5Y5/4
NO MOTTLES OR WATER REFUSAL AT 81"		

PT-H (7/8/19)	DEPTH 48" 3 MPI

PT-I (7/8/19)	DEPTH 54" 2 MPI

LOT 4

DTH-5 (7/8/19)		
0-4"	Ap	SANDY LOAM 10YR3/2
4-25"	Bw	LOAMY SAND 10YR6/8
25-133"	C1	LOAMY SAND 2.5Y5/4
MOTTLES AT 95" NO REFUSAL		

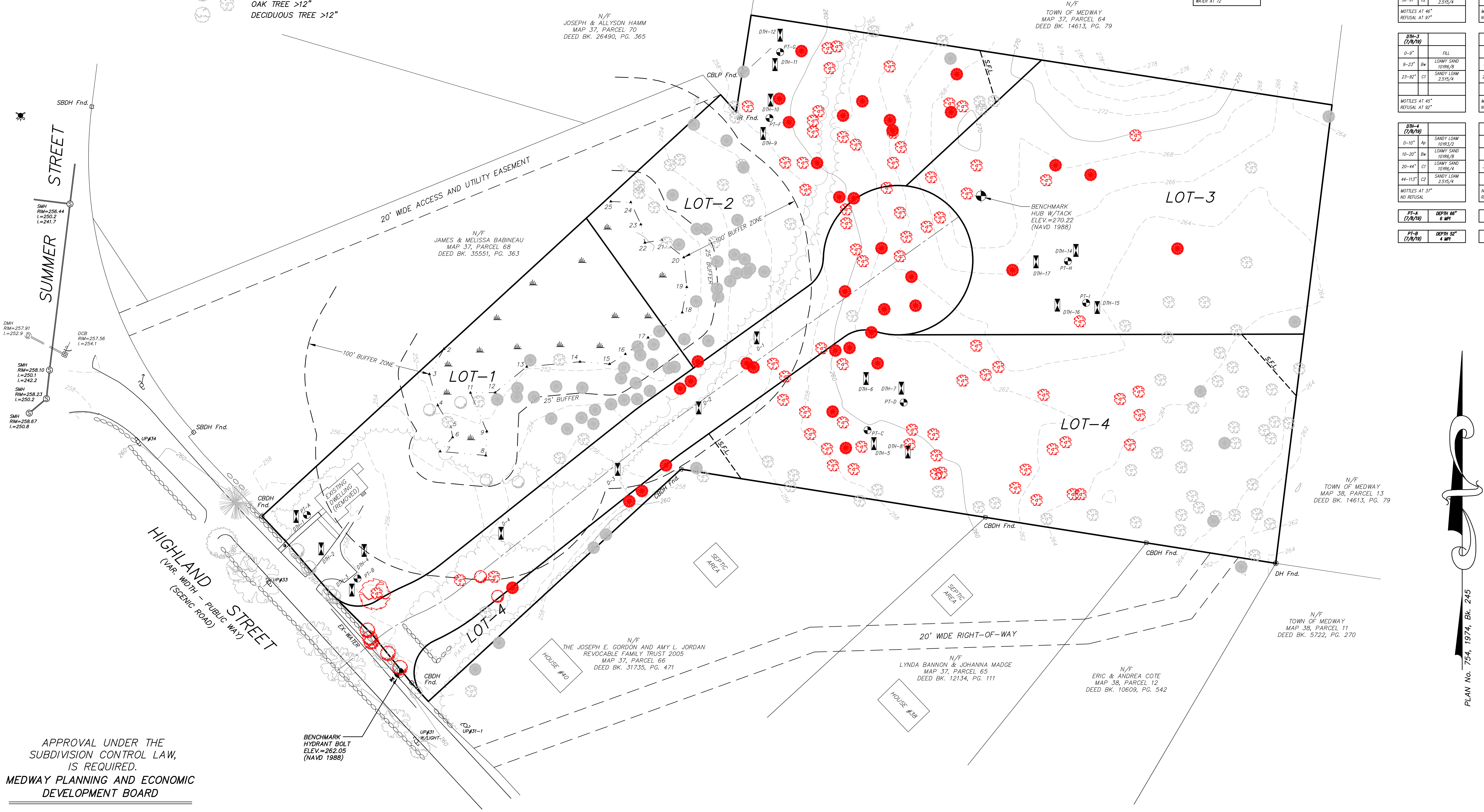
DTH-6 (7/8/19)		
0-6"	Ap	SANDY LOAM 10YR3/2
6-27"	Bw	LOAMY SAND 10YR6/8
27-97"	C1	LOAMY SAND 2.5Y5/4
NO MOTTLES OR WATER REFUSAL AT 97"		

DTH-7 (7/8/19)		
0-7"	Ap	SANDY LOAM 10YR3/2
7-31"	Bw	LOAMY SAND 10YR6/8
31-112"	C1	LOAMY SAND 2.5Y5/4
MOTTLES AT 81" NO REFUSAL		

DTH-8 (7/8/19)		
0-5"	Ap	SANDY LOAM 10YR3/2
5-26"	Bw	LOAMY SAND 10YR6/8
26-61"	C1	FINE SAND 10YR7/1
61-118"	C2	LOAMY SAND 2.5Y5/4
MOTTLES AT 77", WATER AT 102" NO REFUSAL		

PT-C (7/8/19)	DEPTH 49" 5 MPI

PT-D (7/8/19)	DEPTH 51" 5 MPI



ZONED: AR-1
AREA = 44,000 sf
FRONTAGE = 180 feet
SETBACKS: FRONT = 35 feet
SIDE = 15 feet
REAR = 15 feet

ASSESSOR MAP 37, LOT 67

OWNER / APPLICANT:
THE RESIDENCES AT CHOATE TRAIL, LLC
17 GOLDFINCH LANE
NASHUA, NH 03062

CONNORSTONE ENGINEERING INC.
CIVIL ENGINEERS AND LAND SURVEYORS
10 SOUTHWEST CUTOFF, SUITE 7
NORTHBOROUGH, MASSACHUSETTS 01532
PHONE: 508-393-9727 FAX: 508-393-5242

DEFINITIVE SUBDIVISION PLAN
EXISTING CONDITIONS
CHOATE TRAIL WAY
IN
MEDWAY, MASS.

REVISED:	DESCRIPTION:
3/19/2020	PEER REVIEW COMMENTS
3/9/2020	REVIEW COMMENTS
1/13/2020	REVIEW COMMENTS
1/3/2020	REVIEW COMMENTS

DRAWN BY: REM CHECK BY: VC
DATE: NOVEMBER 8, 2019
SCALE: 1"=40' SHEET 1 OF 7

GRAPHIC SCALE: 1"=40'
0 10 20 30 40 50 75 100 150 200 FEET
0 5 10 15 20 30 40 50 60 METERS

APPROVAL UNDER THE
SUBDIVISION CONTROL LAW,
IS REQUIRED.
MEDWAY PLANNING AND ECONOMIC
DEVELOPMENT BOARD

DATE: ______

THIS PLAN IS SUBJECT TO A COVENANT TO BE RECORDED HEREWITH.

I, ______________ CLERK OF THE TOWN OF MEDWAY RECEIVED AND RECORDED APPROVAL FROM THE PLANNING BOARD OF THIS PLAN ON ______________ AND NO APPEAL WAS TAKEN FOR TWENTY (20) DAYS THEREAFTER.

Susan Affleck-Childs

From: cmsmailer@civicplus.com on behalf of Contact form at Town of Medway MA <cmsmailer@civicplus.com>
Sent: Tuesday, April 07, 2020 11:08 AM
To: Susan Affleck-Childs
Subject: [Town of Medway MA] Highland Street New Sub-Development (Sent by Amy Jordan, aljordan1 @yahoo.com)

Hello sachilds,

Amy Jordan (aljordan1@yahoo.com) has sent you a message via your contact form (https://www.townofmedway.org/user/201/contact) at Town of Medway MA.

If you don't want to receive such e-mails, you can change your settings at https://www.townofmedway.org/user/201/edit.

Message:

Hello Susan,

Thank you for speaking to me about the Highland Street Sub-development today.
Unfortunately I had to miss the last meeting. At that time, the proposed easement was discussed for the trail access. 38 Highland Street requested a buffer be planted for privacy and to prevent trail-walking access to properties. We would like a buffer be built on the 40 Highland Property as well. This area has many deer so deer resistant plants such as American Hollies or Hemlocks would be best. Rhododendrons are eaten by the deer each winter. Both 38 and 40 Highland would prefer a simple black metal if possible.

Finally, I need to restate the road once more as I have done in each meeting.
Currently, it is proposed to be a private road managed and maintained by the homeowners. This road has a proposed system to handle the storm water built under the road. If this road fails, it puts my home and property in danger of flooding. The area of water has grown substantially behind 44 and 46 Highland Street since I bought my home in the 90s. Anyhow, please ensure that the ownership of the road is listed on the Deeds of the new home lots.
Also, could a bond to ensure funds are available should the road need maintenance should be in place? Finally, has a plan been developed for snow plowing and placement of snow removal in the winter time?

Thank you,
Amy Jordan

TOWN OF MEDWAY

Planning & Economic Development Board
155 Village Street
Medway, Massachusetts 02053

Request for Medway Treasurer/Collector's Verification of Status of Paid Taxes

Date: April 6, 2020

Applicant's Name: Residences at Choate Trail, LLC

Subject Property Address: 42 and 42R Highland Street

Map/Parcel Number(s): 37-064 and 37-067

Property Owner: Lock It Up, LLC

Project Name: Choate Trail Subdivision

Type of Permit: Definitive Subdivision Plan decision

Please indicate the status of taxes/fees owed to the Town:

- [x] By checking this box and with my signature below, I verify that all taxes and fees owed the Town of Medway ***for the subject property*** are paid in full as of this date for the subject property noted above.

- [ ] By checking this box and with my signature below, I verify that all taxes and fees owed the Town of Medway ***for other properties owned by the applicant*** noted above are paid in full as of this date.

- [ ] By checking this box and with my signature below, I verify that the ***Town is owed taxes or fees*** on properties owned by the above noted applicant. Briefly explain on the lines below. Please attach a report that indicates the property address, what taxes are owed, and the respective amounts.

Signature: Joanne M. Russo Date: 4-6-20

Please complete and return to the Planning and Economic Development office.

TOWN OF MEDWAY
Planning & Economic Development Board

155 Village ST
Medway, Massachusetts 02053

REVISED DRAFT – May 5, 2020

CERTIFICATE OF ACTION
Choate Trail Way Subdivision
DEFINITIVE SUBDIVISION PLAN
__________ with Waivers and Conditions

Location:	42 and 42R Highland Street
Assessors' Reference:	Map 37, Parcels 64 & 67
Parcel Size:	5.88 acres
Name/Address of Applicant:	Residences at Choate Trail, LLC 11 Tanglewood Drive Nashua, NH 03062
Name/Address of Property Owner:	Residences at Choate Trail, LLC 11 Tanglewood Drive Nashua, NH 03062
Engineer:	Vito Colonna, P.E. Connorstone Engineering, Inc. 110 Southwest Cutoff, Suite 7 Northborough, MA 01532
Land Surveyor:	Varoujan Hagopian, P.L.S Connorstone Engineering, Inc. 110 Southwest Cutoff, Suite 7 Northborough, MA 01532
Plan	*Choate Trail Way Subdivision*
Plan Dated:	November 8, 2019, last revised March 8, 2020 to be further revised as specified herein
Zoning District:	Agricultural Residential I
Street Name:	Copper Drive

I. PROJECT DESCRIPTION: The *Choate Trail Way Definitive Subdivision Plan* dated November 8, 2019, last revised January 13, 2020 shows the division of the 5.88 acre parcel of land located at 42 and 42R Highland Street in the Agricultural Residential I zoning district into four residential lots, the construction of an approximately 578 foot private roadway (Copper Drive) and the installation of stormwater management facilities and private sewer and water service. The property is accessed from Highland Street, a Medway Scenic Road. This proposal is for a "by right" use in this zoning district. A portion of this site is in a Wetland Resource Area which is under the jurisdiction of the Medway Conservation Commission for an Order of Conditions and a Land Disturbance Permit. The property is also subject to a Scenic Road Work Permit to be issued by the Planning and Economic Development Board.

II. PROCEDURAL SUMMARY:

A. November 18, 2019, the Planning and Economic Development Board received an application for approval of the *Choate Trail Way Definitive Subdivision Plan*, dated November 8, 2019, prepared by Connorstone Engineering, Inc. of Northborough, MA. The application had been preceded by a preliminary subdivision plan application filed with the Board on September 16, 2019.

B. On December 3, 2019, the Board notified various Town boards and departments, including the Board of Health, of the public hearing on the proposed *Choate Trail Way Definitive Subdivision Plan*, provided copies of the plan, and requested review comments.

C. On December 10, 2019 the Board commenced the public hearing. The public hearing was duly noticed in the *Milford Daily News* on November 26 and December 2, 2019. Notice was posted with the Medway Town Clerk and to the Board's web site on November 21, 2019 and was mailed by *Certified Sent* mail on November 25, 2019 to abutters in Medway within 300 feet of the subject property and to parties of interest. The public hearing was continued to January 28, February 25, 2020, March 24, 2020 and to April 7, 2020 when the hearing was closed, and a decision rendered. During the course of the public hearing, the applicant submitted three revisions to the Choate Trail Way Definitive Subdivision Plan dated January 3, January 13 and March 9, 2020.

D. All members voting on this Subdivision Certificate of Action were present at all sessions of the public hearing or have provided a certification pursuant to General Laws c. 39 section 23D.

III. PUBLIC HEARING SUMMARY: The public hearing and the Board's review of the *Choate Trail Way Definitive Subdivision Plan* were conducted over the course of five Planning and Economic Development Board meetings during which substantive information was presented and evaluated. The plan and its submitted revisions were reviewed for compliance with the *Subdivision Rules and Regulations* dated April 26, 2005 which were in effect at the time the applicant submitted a preliminary subdivision plan to the Board on September 16, 2019.

Specified below is a list of plan documents and support materials, public comments, consultant and town departmental board review documents, and supplemental information which have been provided by the Applicant or placed on the record by the Planning and Economic Development Board. All information is on file in the Medway Planning and Economic Development office and is available for public review (except for confidential communications from Town Counsel).

Choate Trail Way Definitive Subdivision Plan Application Materials

Form C – Definitive Plan Application dated October 15, 2019, received November 18, 2019
Form D – Designer's Certificate dated November 15, 2019 with deed dated August 21, 2018
Form E – Certified Abutters' List dated November 13, 2019
Form F – Development Impact Report received November 18, 2019
Medway Historical Commission letter dated May 2, 2019 with a determination that the house on the property at 42 Highland Street is not historically significant and therefore, may be demolished.
Certificate of Amendment dated September 7, 2018 from Secretary of State William Francis Galvin to change the name of property owner Lock It Up LLC to Residences at Choate Trail, LLC.

Choate Trail Way Definitive Subdivision Plan – Connorstone Engineering, November 8, 2019

Revised – January 3, 2020
Revised – January 13, 2020
Revised – March 9, 2020

Stormwater Report for Choate Trail Way Definitive Subdivision Plan **–** Connorstone Engineering, November 8, 2019

Town Engineering Consultant Reviews **–** Steven Bouley, P.E., Tetra Tech

December 10, 2019
January 23, 2020
March 26, 2020

Town Planning Consultant Review Letters **–** Gino Carlucci, AICP, PGC Associates

December 4, 2019
January 23, 2020
March 31, 2020

Supplemental Information Provided by Applicant's Consultants

Letter from Vito Colonna, PE, Connorstone Engineering, Inc. dated January 14, 2020 in response to plan review comments from Tetra Tech dated December 10, 2019 and PGC Associates dated December 4, 2019, including a truck turning template for Choate Trail Way.

Requests for Waivers from Subdivision Rules and Regulations **–** Prepared by Connorstone Engineering, dated January 13, 2020

Truck Turning Template by Connorstone Engineering, received January 15, 2020

Letter from Vito Colonna, P.E. Connorstone Engineering, dated March 9, 2020 with further plan revisions based on public hearing comments.

Annotated Existing Conditions plan sheet by Connorstone Engineering showing trees expected to be remove during construction, received April 3, 2020

Supplemental Information Entered into the Record by the Medway Planning and Economic Development Board

Mullins Rule certification from Andy Rodenhiser re: the December 10, 2019 hearing
Mullins Rule certification from Andy Rodenhiser re: the February 25, 2020 hearing
Sidewalk construction estimate prepared by Tetra Tech dated February 20, 2020

Decision of the Medway Street Naming Committee dated February 10, 2020 approving Copper Drive as the street name for this subdivision

Citizen/Resident Letters/Communications

Email communication dated December 11, 2019 from Johanna Madge and Lynda Bannon of 38 Highland Street.
Email communicated dated January 28, 2020 from Amy Jordan of 40 Highland Street

Citizen/Resident Testimony

Amy Jordan, 40 Highland Street
Lynda Bannon, 38 Highland Street
Paul Atwood, Medway Trail Club
Johana Madge, 38 Highland Street

Professional Testimony

Gino Carlucci, AICP, PGC Associates, Inc. – Franklin, MA
Steven Bouley, P.E., Tetra Tech – Marlborough, MA
Vito Colonna, P.E. Connorstone Engineering – Northborough, MA

Medway Departmental/Board Review Comments

Email communication dated January 2, 2020 from Deputy Fire Chief Mike Fasolino
Email communication dated January 27, 2020 from Conservation Agent Bridget Graziano
Communication dated February 14, 2020 from Medway Tree Warden Steve Carew

IV. ACTION ON REQUEST FOR WAIVERS OF SUBDIVISION RULES & REGULATIONS –

The Applicant has requested, and the Board has identified needed waivers from the following sections of the *Subdivision Rules and Regulations*, dated April 26, 2005.

7.6.2 UNDERGROUND UTILITIES - g) Other Utilities - Within all lots, underground telephone, electric and cable television lines shall be installed underground within rigid conduits approved by the respective utility companies for each specific purpose. The Applicant shall provide design plans from said utilities to the Board and their agent. Utilities located under the sidewalks are strongly discouraged.

FINDINGS - *Utility poles are located on the opposite side of Highland Street from the subject property. The Applicant's engineering consultant reports that initial feedback from the utility company would be to locate a new pole on the locus property and to make the electrical connection above ground, across Highland Street and then drop to underground service once on-site. The Board's consulting engineer does not recommend this approach as it provides additional overhead crossing on Highland Street and such proposed utility pole would have to be located private property. Further, such additional utility pole may also impact sight lines for vehicles exiting the development.* Therefore, the Board finds that a waiver to allow for the above ground electrical connection across Highland Street is not acceptable.

****

SECTION 7.7.2 STORMWATER MANAGEMENT – (p) Detention and retention basins and underground infiltration systems and any related drainage structures shall be located on separate parcels and shall not be included on individual house/building lots.

FINDINGS - The applicant has proposed installing the stormwater management facilities within the roadway layout of the permanent private way. The PEDB has previously allowed stormwater management facilities to be located within the roadway layout of other private way subdivisions and the Town's consulting engineer has reviewed the proposed stormwater design and recommended suggested revisions which have been incorporated. Therefore, the Board finds that the location of the stormwater facilities within the roadway layout is acceptable.

****

SECTION 7.9.5.(c) STREETS AND ROADWAY – GRADE – At the intersection of street right-of-way lines, there shall be provided in a residential subdivision a leveling (fixed slope) area for at least one hundred feet (100') with a maximum grade of two percent (2%).

FINDINGS – The Applicant has requested a waiver to not be required to have a fixed slope area for at least 100' with a maximum grade of 20%. Instead, the Applicant has proposed a vertical curve within the leveling area. The curve transitions from a -2% slope to a +2% slope so the maximum grade will be over 2%. The curve will minimize the extent of earthwork, reduce the amount of land disturbance and the amount of fill needed and will better match the existing topography. The waiver request has been reviewed by the Town's Consulting Engineer who has no objection to it. Therefore, the Board finds this waiver request to be acceptable.

****

SECTION 7.13.3 SIDEWALKS - Sidewalks shall be provided along the entire frontage of the subdivision parcel along existing Town ways, including the frontage of any lots held in common ownership with the subdivision parcel within five (5) years prior to the submission of the Preliminary or *(if no Preliminary)* Definitive Subdivision Plan. In those instances where sidewalk construction is not feasible or practical, the Applicant shall make a payment in lieu of sidewalk construction to the Town of Medway, in an amount determined by the Town's Consulting Engineer. Such funds shall be deposited to a revolving fund to be used to finance construction of sidewalks and/or other public improvements.

FINDINGS – The applicant has proposed to NOT install sidewalks along the Highland Street frontage of the subdivision. The street does not presently include sidewalks, so no connection point is feasible. The right of way is very narrow, and the installation of a sidewalk would require removal of trees and stone walls along an official "Scenic Road". In lieu of sidewalk construction, the Applicant has agreed to make a payment in lieu of sidewalk construction to the Town's Sidewalk Fund. See Condition # **____**. Therefore, the Board approves this waiver request.

****

7.21.1 STREETLIGHTS - It shall be the responsibility of the developer to install street lighting within the subdivision, at the entrance to the subdivision, at all intersections within the subdivision, sharp turns, or other areas where the Traffic Safety Officer deems they are needed for public safety. The quantity, type and location of lights shall be shown on the definitive plan. The developer is responsible for installing the pole, wiring and arranging installation of the light fixture.

FINDINGS - The applicant proposes to not install typical streetlights within the subdivision, but to have individual lot light posts. The Police Department's Traffic Safety Officer has recommended the installation of a streetlight on existing utility pole #33 on the west side of Highland Street north of the proposed Copper Drive entrance into the development which the applicant will install as part of this project. See Condition # ____. Therefore, the Board approves the waiver request to not install streetlights within the subdivision itself.

MITIGATION PLAN

A. The Applicant shall make a payment to the Town in the amount of $10,085 in lieu of constructing sidewalk along the Highland Street frontage of the Choate Trail Way Subdivision.
B. The new road and associated sidewalk will be private in perpetuity, owned and maintained by the homeowners association, thus relieving the Town of this on-going responsibility and expense.
C. Maintenance and upkeep of the stormwater management facilities will be the responsibility of the homeowners association, thus relieving the Town of this on-going responsibility and expense.
D. **On-site tree preservation. .** ..
E. Provision of a 15’ trail easement on Lot #4 and construction of a 5’ wide trail within the easement.
F. Installation of a streetlight on Utility Pole #33 on the west side of Highland Street.

ACTION ON WAIVERS **–** At a duly called and properly posted meeting of the Medway Planning and Economic Development Board held on ___________________, a motion was made by ____________________ and seconded by ___________________to approve the above noted waiver requests from the *Subdivision Rules and Regulations*. The motion was ______________by a vote of _____in favor and ______opposed.

V. PROJECT EVALUATION CRITERIA **–** Before taking action on a definitive subdivision plan, the Board shall evaluate the proposed subdivision according to the criteria as specified in Section 5.16 of the *Subdivision Rules and Regulations*. At a duly called and properly posted meeting of the Medway Planning and Economic Development Board held on ___________________ a motion was made by ______________and seconded by ______________to ___________the Project Evaluation Findings noted below. The motion was ___________by a vote of ____ in favor and _____ opposed.

5.16.1 Completeness and technical accuracy of all submissions.

FINDINGS – All submissions were reviewed by Town staff and/or the Town’s Consulting Engineer and Consulting Planner and no significant missing or technical inaccuracies were identified.

5.16.2 Determination that the street pattern is safe and convenient, and that proper provision is made for street extension. The Board may disapprove a plan where it determines that dangerous traffic or unsafe conditions may result from the inadequacy of the proposed ways within the subdivision.

FINDINGS – The Board finds that the proposed street pattern within the new subdivision is safe and convenient. The layout has been reviewed by the Town’s Fire Chief, and Consulting Engineer. Comments from them have been incorporated into the design. Future roadway extension to adjacent property is not feasible as the adjacent property is owned by the Town of Medway, so provisions to do so are not required.

5.16.3 Determination that development at this location does not entail unwarranted hazard to the safety, health and convenience of future residents of the development or of

others because of possible natural disaster, traffic hazard or other environmental degradation.

FINDINGS – The Board finds that the location of the development does not entail unwarranted hazard. A drainage plan has been designed to handle anticipated stormwater runoff and the sight distances from the proposed roadway's intersection with Highland Street are adequate. Erosion controls will be in place during construction. The property is subject to an Order of Conditions from the Medway Conservation Commission.

5.16.4 Determination, based on the environmental impact analysis, where submitted, that the subdivision as designed will not cause substantial and irreversible damage to the environment, which damage could be avoided or ameliorated through an alternative development plan.

FINDINGS – The site of the subdivision is not within a Priority Habitat area and the wetlands of the site will be protected through action of the Medway Conservation Commission. Stormwater management has been reviewed by the Town's consulting engineer and is adequately addressed. There will be an increase of only three single-family houses to be constructed. Significant trees on site that are not within the house footprints or infrastructure elements will be protected and retained. The Board finds that the subdivision will not cause substantial and irreversible damage to the environment.

5.16.5 Determination that the roads and ways leading to and from the subdivision shall be adequate to provide emergency medical, fire and police protection as well as safe travel for the projected volume of traffic. The Board may disapprove a plan where it determines that dangerous traffic or unsafe conditions may result from the inadequacy of the proposed access or of any ways adjacent to or providing access to the subdivision.

FINDINGS – The Board finds that the Highland Street is adequate to provide emergency medical, fire and police protection as well as safe travel for the anticipated volume of traffic generated by five residences. The plans have been reviewed by the Fire Chief and Consulting Engineer. Comments from them have been incorporated into the design. The roadway shown on the plan will be built according to the Board's construction specifications for Neighborhood Streets. The 20-foot roadway width meets national Fire Code standards while also reducing impervious surfaces and stormwater impacts.

5.16.6 Conformity with all applicable requirements of the Medway Zoning Bylaw including but not limited to minimum area and frontage standards.

FINDINGS – The Board finds that the lots created by this plan conform to all applicable requirements of the Medway Zoning Bylaw, including minimum area and frontage requirements for the Agricultural Residential I zoning district.

5.16.7 Consistency with the purposes of the Subdivision Control Law.

FINDINGS – The Board finds that the proposed subdivision is consistent with the purposes of the Subdivision Control Law because the infrastructure proposed is adequate for the new development and the impacts of the subdivision have been mitigated to a reasonable extent. Reasonable waivers have been granted herein with good cause.

VI. DECISION – At a duly called and properly posted meeting of the Medway Planning and Economic Development Board held on_______________, a motion was made by ___________and seconded by ________________to approve the ***Choate Trail Way Definitive Subdivision Plan***, prepared by Connorstone Engineering, dated November 8, 2019, last revised March 9, 2020 subject to the Specific and General Conditions as specified herein and with Waivers from the following sections of the *Subdivision Rules and Regulations* dated April 25, 2005.

- __________
- __________
- __________
- __________
- ___________

The motion was ____________by a vote of _________in favor and _________opposed.

VII. CONDITIONS – The following specific and general conditions shall apply to the Applicant, its executors, administrators, devisees, heirs, successors and assigns:

A. Specific Conditions

1. ***Authorization*** - The Choate Trail Way subdivision is authorized for no more than four residential house lots. As a permanent condition of the approval of this plan, no further subdivision of the property beyond these four lots is allowed, although lot boundaries within the subdivision may be adjusted so long as no additional lots are created.

2. ***Completion Schedule*** - The Applicant or its Assignee shall construct the roadway and all related infrastructure including the stormwater management system, and install all utilities as shown on the endorsed Choate Trail Way Definitive Subdivision Plan, to the satisfaction of the Planning and Economic Development Board, within three (3) years of the date of endorsement of the plan. The time for such construction and/or installation may be extended upon the written request of the applicant, for good cause shown, prior to the expiration of the three (3) year period, upon a vote of the majority of the Planning and Economic Development Board then present.

3. ***Plan Revisions*** - Prior to plan endorsement, the Choate Trail subdivision plan dated March 9, 2020 shall be further revised to include the following:
   - A note shall be added to all plan sheets indicating that the plan is subject to this Certificate of Action which shall be recorded with the Plan at the Norfolk County Registry of Deeds.
   - The cover sheet shall be revised:
     - ❖ to prominently display the plan name and date
     - ❖ to indicate APPROVED WAIVERS instead of WAIVER REQUESTS.
     - ❖ to remove the list of abutters
     - ❖ to reduce the size of the locus
     - ❖ to include an index of all plan sheets
   - The property addresses for the four Copper Drive house lots, to be provided by the Medway Assessor's office, shall be added to the plan sheets.
   - The signature area on the plan sheets shall be revised to add a space for the plan endorsement date.
   - A note shall be added to all plan sheets to indicate that present and future owners are subject to a *Declaration of Protective Covenants & Restrictions and Private Roadway Agreement Governing the Choate Trail Subdivision*

- A 15' "selective cut zone" around the non-street perimeter of each house lot shall be shown on the plan sheets
- The plan shall be revised, and a detail shall be added to specify the installation of a Town of Medway approved streetlight on utility pole #33 on Highland Street as an off-site mitigation measure.
- To include a sheet providing the Stormwater Pollution Prevention Plan for construction.
- The existing conditions sheet shall be revised to display trees to be removed during the construction process.
- Modify the note on Sheet 3 of 7 to specifically call out that all elec/tel/cable/space lines within the subdivision shall be located underground.
- Modify the note on Sheet 3 of 7 to remove reference to overhead connection from existing utility pole #33 to a new utility pole on lot 1 replace it with a note that such connection shall be done underground.
- Renumber the plan sheets.

4. ***Documents to be Prepared and Approved Before Endorsement*** – Prior to plan endorsement, the Applicant shall provide the following documents for review, comments, amendment and approval by Town Counsel and the Board.

   a. **Subdivision Covenant** – Prior to endorsement, the Applicant shall sign a Subdivision Covenant, on a form acceptable to the Planning and Economic Development Board, to secure construction of the ways and all related infrastructure and installation of utilities and services and any off-site mitigation measures as specified in the approved subdivision plan. Reference to the *Subdivision Covenant* shall be noted on the cover sheet of the Definitive Subdivision Plan. The *Subdivision Covenant* shall specify that the roadway and all relevant infrastructure including the stormwater management system shall be constructed and all utilities and services and any off-site mitigation measures shall be installed to the satisfaction of the Planning and Economic Development Board within three years of the date of plan endorsement. The Subdivision Covenant shall apply to Lots 1 – 4 as shown on the plan.

   b. **Trail Easement –** Prior to plan endorsement, the Applicant shall provide a trail easement document, suitable for recording, to authorize public access on Copper Drive and on the 15' wide trail easement located along the southern boundary of Lot #4.

   c. **Articles of Association or Incorporation** - Prior to plan endorsement, the Applicant shall provide a proposed Articles of Association or Incorporation establishing the homeowners' association. This document shall include provisions for membership by the owners of Lots 1 – 4, management responsibilities, procedures for voting and fee assessment, and for the ownership and financial responsibility for the on-going maintenance, upkeep and repair of Copper Drive including but not limited to snowplowing and sanding, the stormwater management system and the landscaped island in the cul-de-sac. The documents shall specify that the costs shall be divided equitably among the members.

   d. **Lot Deeds –** Prior to plan endorsement, the Applicant shall provide the proposed deeds to convey each of the house lots to future owners. Each lot deed shall reference the Choate Trail Definitive Subdivision plan, the 15' no cut zone pursuant to Condition # ___, and clearly state that the Choate Trail Homeowners Association shall be responsible for the maintenance and upkeep of Copper Drive as a permanent private road and the stormwater drainage system. The deed for lot #4 will specifically reference the trail easement pursuant to Condition # ___. The deeds shall specify that the future owners will own to the centerline of the roadway along their property's frontage. However, the Applicant shall reserve to itself ownership of an easement in Copper Drive for future conveyance to the future Choate Trail Subdivision Homeowners Association.

e. **Declaration of Protective Covenants and Restrictions and Private Roadway Agreement Governing the Choate Trail Way Subdivision -** Prior to plan endorsement, the Applicant shall provide a proposed *Declaration of Protective Covenants & Restrictions and Private Roadway Agreement Governing the Choate Trail Way Subdivision.* See Condition # ____

f. **Road Easement** – Prior to plan endorsement, the Applicant shall provide a document to be used to convey an easement on Copper Drive and all associated drainage and utility easements shown on the plan to the Choate Trail Homeowners Association.

5. ***Plan Endorsement***

a. Within sixty days after the Board has filed this decision with the Town Clerk but no sooner than twenty days after the decision is filed with the Town Clerk, the Applicant shall submit a revised subdivision plan reflecting all Conditions and required revisions as specified herein, to the Planning and Economic Development Board and the Town's Consulting Engineer, for review and approval prior to plan endorsement. All conditions of this Certificate of Action requiring changes to the definitive subdivision plan must be addressed to the satisfaction of the Town's Consulting Engineer and the Planning and Economic Development Board before the Board will endorse the definitive subdivision plan.

b. The endorsed plan shall bear the certification of the Town Clerk that twenty days have elapsed after the decision was filed in the Town Clerk's office and no appeal has been filed within said twenty-day period.

c. Within thirty days after plan endorsement, the Applicant shall provide the Town with a set of the approved plan in 24" x 36" paper format. The Applicant shall also provide the approved plan in pdf format and CAD format compatible with the Medway GIS and acceptable to the Medway Board of Assessors (ArcInfo shape file - .shp). The Applicant shall pay any reasonable associated costs, as may be determined by the Board of Selectmen, to update the Medway GIS/Assessor's maps relative to this subdivision.

6. ***Recording*** – The Applicant shall record this decision, the endorsed definitive subdivision plan, and the subdivision covenant at the Norfolk County Registry of Deeds. Within thirty days of such recording, the Applicant shall provide proof of recording to Planning and Economic Development Board. No construction shall begin on the site and no building permit shall be issued before these documents are recorded. The fee for recording or registering shall be paid by the Applicant.

7. ***Selective Cut Zones*** – A 15' selective cut zone shall be established around the non-street perimeter of each house lot. During construction, the area included in the selective cut zones shall not be disturbed. Future property owners shall maintain the selective cut zone as a landscaped and wooded buffer without intrusion. However, pruning necessary for removal of dead/damaged/ diseased or harmful plant materials and additional landscape planting is permitted.

8. ***Tree Preservation*** – The Existing Conditions sheet of the plan set shows 262 pine, maple, oak, and other deciduous trees larger than 12 inches in diameter located on the subject property.

a. The Applicant expects to remove ≈115 of these trees for construction of the roadway, infrastructure, house and septic system; these are indicated on the Existing Conditions sheet.

The remaining ≈147 trees shall be clearly identified in the field and such markings shall be verified by the Town's consulting engineer before site preparation and construction commences.

b. The applicant shall make the fullest possible effort to preserve/retain the ≈147 remaining trees and prevent their removal, demise or damage during construction including all such trees located in the designated 15' no-cut zones on the non-street perimeter of each lot.

c. If any of the above noted trees designated to be preserved/retained are removed or damaged during construction, the applicant shall be responsible for tree restoration by replacing the removed or damaged trees with nursery grade trees on a one (1) square inch per two (2) square inch replacement basis. The one (1) square inch per two (2) square inch replacement amount is calculated by squaring 1/2 the established diameter of each tree that is removed or damaged and multiplying that amount by 3.14 to determine its trunk area (tree radius squared x pi rounded to 3.14). The resulting figure is halved, and that square inch total is the amount of required square inches of the replacement tree(s). A 3" caliper tree equals seven (7) sq. inches. The location of the replacement trees on the house lots shall be recommended by the applicant and approved by the Planning and Economic Development Board and Tree Warden. The restoration shall be verified by the Tree Warden as being fully and skillfully performed. The species of replacement tree(s) shall be reviewed and approved by the Tree Warden, or otherwise will be consistent with the species of the removed tree(s).

d. In lieu of tree planting on the subject property, the Applicant may make a contribution to the Medway Tree Fund in an amount to be determined by the Board upon consultation with the Medway Tree Warden based on wholesale pricing for 3-inch caliper trees from a reputable area landscape supplier. The Applicant may also combine tree planting and a contribution in lieu of tree-planting to be approved by the Board.

e. Any such supplemental tree planting shall occur before the occupancy permit is issued for the respective lot. Any contribution in lieu of tree planting shall occur before the occupancy permit is issued for the last of the four houses.

9. ***Sidewalk Construction*** – In lieu of constructing a sidewalk along the frontage of 42 Highland Street, the applicant shall provide $10,085 to the Medway Sidewalk Fund. This amount shall be provided before the Building Department issues an occupancy permit for the second house in the subdivision.

10. ***Trail*** **–** The Applicant shall construct a 5' winding dirt trail within a 15' wide trail access located along the southern length of Lot #4. The trail and the associated buffer area landscaping along the southern boundary of Lot #4 within the trail easement area shall be completed before the Building Department issues an occupancy permit for the house to be constructed on Lot #4.

11. ***Scenic Road Work Permit*** – This project is also subject to a Scenic Road Work Permit issued by the Board. As a condition of this decision, the Applicant shall comply fully with the requirements of the Scenic Road work permit. MORE NEEDED HERE

12. ***Ownership of Copper Drive*** – The roadway depicted on this subdivision plan shall remain privately owned in perpetuity to the center line by the owners of the four lots. There is no intention or expectation that the Town of Medway will ever accept the roadway as constructed pursuant to this plan.

13. ***Homeowners Association*** - There shall be established a Choate Trail Subdivision Homeowners Association to be responsible for the maintenance and upkeep of the roadway including but not limited to snowplowing and sanding, maintaining the stormwater detention/infiltration system and related infrastructure located within the roadway right of way, maintaining the sidewalk along Copper Drive, and maintaining the landscaped island in the cul-de-sac.

14. ***Declaration of Protective Covenants & Restrictions and Private Roadway Maintenance Agreement Governing the Choate Trail Way Subdivision*** – The future owners of lots 1-4 are subject to a *Declaration of Protective Covenants & Restrictions and Private Roadway Agreement Governing the Choate Trail Way Subdivision* to be executed and recorded with the definitive subdivision plan. Prior to endorsement, the Applicant shall provide a proposed *Declaration of Protective Covenants & Restrictions and Private Roadway Agreement Governing the Choate Trail Way Subdivision* to be reviewed and approved by Town Counsel and the Planning and Economic Development Board. At a minimum, the *Declaration of Protective Covenants & Restrictions and Private Roadway Agreement Governing the Choate Trail Way Subdivision* shall include language regarding the property owners' responsibility through a homeowners' association for the upkeep, repair, and on-going maintenance of the roadway including snowplowing and sanding, the operation and maintenance of the stormwater management system, maintaining the sidewalk along Copper Drive, and the upkeep of the landscaped island in the cul-de-sac. The Agreement shall specifically refer to the Long-Term Pollution Prevention Plan and associated Stormwater Operations and Management Plan included in the Choate Trail Way Stormwater Report dated November 8, 2019, last revised ____________, prepared by Connorstone Engineering and approved by the Medway Conservation Commission.

15. ***Maintenance Responsibility During Construction*** – The Applicant shall provide for snow plowing, sanding and full maintenance of Copper Drive, and all related stormwater management infrastructure throughout the entire construction process until the roadway is determined to be complete by the Board and an easement is granted to the homeowners association. This includes keeping the constructed stormwater drainage system in a clean and well-functioning condition in accordance with the Stormwater Pollution Prevention Plan included in the most recent version of the Choate Trail Way Subdivision Stormwater Report prepared by Connorstone Engineering. The Applicant shall do nothing which would alter the drainage patterns or characteristics as shown on the approved plan.

16. ***Stormwater Management During Construction* – Construction is subject to the Storm Water Pollution Plan within the Storm Water Report for Choate Trail Way dated _______, prepared by ________________________**

    a. This document shall be included in all construction contracts, subcontracts and specifications dealing with the proposed work. The applicant shall ensure that all contractors, subcontractors and other personnel performing the permitted work are fully aware of the Construction Period Operation and Maintenance Plan.

    b. No clearing of vegetation, including trees, or disturbance of soil shall occur prior to the Pre-Construction Meeting.

    c. Prior to the Pre-Construction Meeting and commencement of any activity on the site, the erosion control plan included in the endorsed plan set and the limit of work lines shall be staked. The location of erosion controls shall be adjusted, if necessary, during the first erosion control inspection.

d. Immediately after installation of erosion controls, the Applicant shall notify the Board's consulting engineer to schedule a follow-up inspection to ensure that erosion controls and limits of work have been properly located and installed. No work shall be conducted until the Board's consulting engineer has inspected and approved the installation of the erosion controls.

e. It shall be the responsibility of the Applicant to conduct monitoring, maintenance and repair of erosion control measures, as well as to take any other additional measures necessary to control erosion from the site. The erosion control measures designated on the subdivision plan shall be considered a minimum standard for compliance.

f. All waste products, refuse, debris, grubbed stumps, slash, excavate, construction materials, etc. associated with the planned construction shall be contained and ultimately deposited at an appropriate off-site facility and shall not be incorporated in any manner into the project site.

17. ***Maintenance Post Construction*** – As Copper Drive shall be a permanent, private roadway, the ongoing maintenance responsibility for it, all associated infrastructure and the stormwater management system will ultimately rest with the Choate Trail Subdivision Homeowners Association. The Town of Medway shall not have, now or ever, any legal responsibility for operation or maintenance of the roadway, sidewalks, curbing, snowplowing, stormwater system, sanding, streetlights, or upkeep of the landscaped island in the Copper Drive cul-de-sac; that responsibility rests with the Homeowners Association. The Association shall maintain the stormwater management system in accordance with the long-term stormwater operation and maintenance plan included with the stormwater report.

18. ***Water Conservation*** – The Applicant shall incorporate the following water conservation measures for construction of the development:
    a. rain gauge-controlled irrigation systems
    b. low flow household fixtures
    c. water efficient appliances (dishwashers, washer/dryers, toilets, etc.)

19. ***Addresses*** – The addresses for the four house lots shall be as determined by the Medway Assessor's office upon consultation with the Medway Fire and Police Departments.

20. ***Development Signage*** – Any development signage for this project during construction and for permanent identification signage thereafter shall comply with the sign regulations of the *Bylaw*.

21. ***Order of Conditions*** – As a component of this development, the Applicant shall comply fully with the Order of Conditions and the associated Land Disturbance Permit issued by the Medway Conservation Commission on _________________.

22. ***Underground Utilities*** – All electrical, telephone, cable TV, and other utilities shall be located underground.

23. ***Off-Site Mitigation*** – As requested by the Medway Police Department, the Applicant shall purchase and install a Town approved streetlight fixture on utility pole #33 on the west side of Highland Street. This work shall be coordinated with the Medway Department of Public Works and shall be completed before the occupancy permit is issued for the fourth house.

B. Standard Conditions

1. ***Expiration of Appeal Period*** – Prior to endorsement of the definitive subdivision plan, the Planning and Economic Development Board must receive the statutory notification of the expiration of the twenty-day appeal period from the Town Clerk's office.

2. ***Payment of Balance of Fees*** – Prior to plan endorsement, the Applicant shall pay the balance of any outstanding plan review services by any outside consultants retained by the Planning and Economic Development Board.

3. ***Proof of Taxes Paid*** – Prior to the Planning and Economic Development Board's endorsement of the plan, approval of the *Release of Covenant* for the first building lot, and any form of surety reduction, proof is required from the Medway Town Treasurer/ Collector that all real estate taxes and other municipal fees and charges are current for the property included in this subdivision and for all property owned in Medway by the applicant.

4. ***Site Access*** - Planning and Economic Development Board members, its staff, consultants or other designated Town agents and staff shall have the right to inspect the site at any time during construction for compliance with the endorsed subdivision plan and the provisions of this Decision.

5. ***Construction Oversight***

   a. Construction Account

      1) Inspection of roadway and infrastructure and utility construction, and installation of site amenities including landscaping by the Town's Consulting Engineer and review of legal documents by Town Counsel are required. Prior to plan endorsement the Applicant shall pay a construction services fee to the Town of Medway to establish a construction services account for such inspections and legal services. The amount shall be determined by the Planning and Economic Development Board based on an estimate provided by the Town's Consulting Engineer based on the scope of the project. The funds may be used at the Board's discretion to retain professional outside consultants to perform the items listed above as well as the following other tasks - inspect the site during construction/installation, identify what site work remains to be completed, prepare bond estimates, conduct other reasonable inspections until the site work is completed and determined to be satisfactory, review as-built plans, and advise the Board as it prepares to issue authorize project completion.

      2) Depending on the scope of professional outside consultant assistance that the Board may need, the Applicant shall provide supplemental payments to the project's construction inspection account, upon invoice from the Board, for reasonable additional construction services until the road construction and stormwater drainage system and other utilities are completed and the as-built plan has been reviewed and determined to be satisfactory.

      3) Any funds remaining in the Applicant's construction inspection account after project completion shall be returned to the Applicant.

   b. The Department of Public Works will conduct inspections for any construction work occurring in the Town's right-of way in conjunction with the Town of Medway Street Opening/Roadway Access Permit and any utility connection permits.

   c. The Applicant shall have a professional engineer licensed in the Commonwealth of Massachusetts conduct progress inspections of the construction of the approved site improvements. Inspections shall occur at least on a monthly basis. The engineer shall prepare a written report of each inspection and provide a copy to the Board within 5 days of inspection. Failure of the Permittee to provide these reports may be reason to withhold building or occupancy permits.

6. ***Other Permits*** – This permit does not relieve the applicant from its responsibility to obtain, pay and comply with all other required federal, state and Town permits. The contractor for the applicant or assigns shall obtain, pay and comply with all other required Town permits.

7. ***Pre-Construction Meeting*** – At least seven days prior to the start of any site preparation or construction, a pre-construction meeting shall take place with the Town's Consulting Engineer, the Planning and Economic Development Coordinator, the Medway Department of Public Works, the Medway Conservation Agent, the developer and site contractors. The construction schedule shall be reviewed and the procedures for inspections discussed. A copy of the final Stormwater Pollution Prevention Plan (SWPP) as filed DEP shall be provided to the Town.

8. ***Restrictions on Construction Activities*** – During construction, all local, state and federal laws shall be followed regarding noise, vibration, dust and blocking of Town roads. The applicant and its contractors shall, at all times, use all reasonable means to minimize inconvenience to abutters and residents in the general area. The following specific restrictions on construction activity shall apply.

   a. *Construction Time* - Construction work at the site and in the building and the operation of construction equipment including truck/vehicular and machine start-up and movement shall commence no earlier than 7 a.m. and shall cease no later than 6 p.m. Monday – Saturday. No construction shall take place on Sundays or legal holidays without the advance approval of the Inspector of Buildings.

   b. *Neighborhood Relations* – The applicant shall notify neighbors in the general area around the site when site work and construction are scheduled to begin and provide a phone number for them to use for questions and concerns that arise during construction.

   c. The applicant shall take all measures necessary to ensure that no excessive dust leaves the premises during construction including use of water spray to wet down dusty surfaces.

   d. There shall be no tracking of construction materials onto any public way. Daily sweeping of roadways adjacent to the site shall be done to ensure that any loose gravel/dirt is removed from the roadways and does not create hazardous or deleterious conditions for vehicles, pedestrians or abutting residents. In the event construction debris is carried onto a public way, the Applicant shall be responsible for all clean-up of the roadway which shall occur as soon as possible and in any event within twelve (12) hours of its occurrence.

   e. The Applicant is responsible for having the contractor clean-up the construction site and the adjacent properties onto which construction debris may fall on a daily basis.

   f. All erosion and siltation control measures shall be installed by the Applicant prior to the start of construction and observed by the Planning and Economic Development Board's consulting engineer and maintained in good repair throughout the construction period.

   g. *Construction Traffic/Parking* – During construction, adequate provisions shall be made on-site for the parking, storing, and stacking of construction materials and vehicles. All parking for construction vehicles and construction related traffic shall be maintained on site. No parking of construction and construction related vehicles shall take place on adjacent public or private ways or interfere with the safe movement of persons and vehicles on adjacent properties or roadways.

h. *Noise* - Construction noise shall not exceed the noise standards as specified in the *Zoning Bylaw*, Section 7.3.C.2. Environmental Standards.

9. ***Building Permits*** – Pursuant to Section 6.6.3 of the *Subdivision Rules and Regulations*, the Applicant shall not be allowed to secure a building permit until the following items, at a minimum, have been installed, inspected and approved by the Board or its agent:
   a) Gravel subbase
   b) Binder course
   c) Drainage system completed to the proposed outfall with frame and grates set to binder grade, as well as detention basins, swales, infiltration systems or any other stormwater management facilities.
   d) As-built plan of each detention pond and forebay contoured in two-foot (2') intervals; and all critical elevations and details of the structures, pipes and headwalls within the detention pond area.
   e) Street name signs and *"Street Not Accepted by the Town"* signs in a size and form as specified by the Medway Department of Public Services, and all regulatory signs as specified in the approved plan.
   f) Stop line pavement markings.
   g) Sidewalk binder
   h) Provisions for fire prevention and protection, such as a cistern, dry hydrant system or municipal water service constructed, installed and functional in the area of the subdivision in which the lots are located.

10. ***Subdivision Performance Surety***

   a. *Alternative Performance Security* - At such time as the Applicant wishes to secure a building permit for any lot within the subdivision, the security provided by the *Subdivision Covenant* shall be replaced by a subdivision surety in compliance with General Laws chapter 41 §81U and the Board's *Regulations*, which method or combination of methods may be selected and from time to time varied by the Applicant, in a sufficient amount, source and form acceptable to the Board, the Treasurer/Collector and Town Counsel. The surety shall be provided prior to the Planning and Economic Development Board's approval of the *Release of Covenant* for any house lot.

   b. *Surety Amount* - The amount of the performance guarantee shall be equal to 100% of the amount that would be required for the Town of Medway to complete construction of the roadway and installation of stormwater management facilities, utilities, services, pedestrian facilities and all site amenities as specified in the Decision and Plan that remain unfinished at the time the performance guarantee estimate is prepared if the Permittee failed to do so. The security amount shall be approved by the Planning and Economic Development Board based on an estimate provided by the Town's Consulting Engineer based on the latest weighted average bid prices issued by the Mass Department of Transportation. The estimate shall reflect the cost for the Town to complete the work as a public works project which may necessitate additional engineering, inspection, legal and administrative services, staff time and public bidding procedures. The estimate shall also include the cost to maintain the roadway and infrastructure in the event the Permittee fails to adequately perform such. In determining the amount, the Board shall be guided by the following formula in setting the sum: estimate of the Town's Consulting Engineer of the cost to complete the work plus a 30% contingency.

c. *Surety Agreement* - The Applicant shall enter into a surety agreement with the Planning and Economic Development Board as provided in the *Regulations* to define the obligations of the Applicant and the performance guarantee company including:
   1) the date by which construction shall be completed
   2) a statement that the agreement does not expire until released in full by the Board
   3) procedures for collection upon default.

d. *Minimum Work for Lot Release* - Prior to releasing any lots from the *Subdivision Covenant*, the following items shall be installed and inspected and approved by the Board:
   1) Roadway gravel sub-base (excluding driveways)
   2) Roadway binder course (excluding driveways)
   3) Drainage system completed to proposed outfall with frame and grates set to binder grade, as well as stormwater basins, swales, infiltration systems or any other stormwater management facilities.
   4) As-built plan for each drainage system
   5) Private road street name sign in a size and form specified by the Medway Department of Public Works, and all regulatory signs as specified on the approved plan.
   6) Stop line pavement markings.

e. *Adjustment of Performance Guarantee* - At the Applicant's written request, the amount of the performance guarantee may be reduced from time to time over the course of the construction project by vote of the Board upon the partial completion of the roadway and infrastructure improvements as defined herein. In order to establish the amount to adjust the performance guarantee, the Town's Consulting Engineer shall prepare an estimate of the current cost for the Town to complete all work as specified on the approved Plan that remains unfinished at the time the estimate is submitted to the Board. The estimate shall be based on unit prices in the latest Weighted Average Bid Prices issued by the Mass Department of Transportation. The estimate shall reflect the cost for the Town to complete the work as a public works project, which may necessitate additional engineering, inspection, legal and administrative fees, staff time and public bidding procedures. The estimate shall also include the cost to maintain the roadway and infrastructure in the event the Permittee fails to adequately perform such. In determining the amount of the adjustment of the performance guarantee, the Board shall be guided by the following formula to determine the reduction amount: the estimate of the Town's Consulting Engineer of the cost to complete the work; plus, a 30% contingency. The Board may authorize up to three reductions in the amount of performance security however, the Board shall not reduce the performance security below $40,000.

f. *Final Release of Performance Security* - Final release of performance security is contingent on project completion.

11. ***Compliance with Plan and Decision***

a. All construction shall be as specified in the approved definitive subdivision plan and any modifications thereto and in full compliance with the *Subdivision Rules and Regulations* and all applicable local, state and federal laws, including but not limited to the Americans with Disabilities Act, the NPDES permit requirements, the Massachusetts Department of Environmental Protection Stormwater Management Policy requirements, MEPA requirements, the Massachusetts Wetland Protection Act (Chapter 131, Section 40, M.G.L.) and the regulations of the Massachusetts Architectural Access Board for handicap accessibility.

b. The Planning and Economic Development Board or its agent(s) shall use all legal options available to it, including referring any violation to the Building Commissioner/Zoning Enforcement Officer for appropriate enforcement action, to ensure compliance with this Decision.

c. The Conditions of Approval are enforceable under Section 3.1. F. of the *Medway Zoning Bylaw* (non-criminal disposition) and violations or non-compliance are subject to the appropriate fine.

12. ***On-Site Field Changes***

a. During construction, the Permittee may be authorized to make limited, minor, on-site field changes to the approved plan based on unforeseen site or job conditions, situations, or emergencies necessitated by field conditions or due to practical considerations. These field changes shall not alter items which may affect the site's compliance with this decision and the *Bylaw* nor conflict with a specific condition of the decision. Field changes shall not substantially alter the intent, layout or design of the endorsed plan.

b. Prior to undertaking such field changes, the Permittee and/or contractor shall discuss the possible field changes with the Town's Consulting Engineer and submit a letter and drawings to the Planning and Economic Development Coordinator and the Building Commissioner describing the proposed changes and what conditions, situations, or emergencies necessitate such changes. The Building Commissioner may determine that the field change is insubstantial, authorize the change, and so notify the Board. Otherwise, the Board shall review the proposed field changes at a public meeting and determine whether the proposed field changes are reasonable and acceptable based on the unforeseen conditions, situations, or emergencies and whether other options are feasible or more suitable. A written authorization of field change will be provided. Any approved field change shall be reflected in the as-built plan to be provided at project completion.

13. ***Modification of Plan and/or Decision***

a. Proposed modifications to the plan or decision, not included on-site field changes, shall be subject to review by the Board.

b. This approval is subject to all subsequent conditions that may be imposed by other Town departments, boards, agencies or commissions. Any changes to the plan that may be required by the decisions of other Town boards, agencies or commissions shall be submitted to the Planning and Economic Development Board for review as a subdivision plan modification.

c. Any work that deviates from the approved subdivision plan or this Decision shall be a violation of the *Medway Zoning Bylaw*, unless the Applicant requests approval of a plan modification and such approval is provided in writing by the Planning and Economic Development Board.

d. Whenever additional reviews by the Planning and Economic Development Board, its staff or consultants are necessary due to proposed subdivision plan modifications, the Applicant shall be billed and be responsible for all supplemental costs including filing fees, plan review fees and all costs associated with another public hearing including legal notice and abutter notification. If the proposed revisions affect only specific limited aspects of the site, the Planning and Economic Development Board may reduce the scope of the required review and waive part of the filing and review fees.

e. The Board shall issue its Modification Decision, file such with the Town Clerk and provide copies to the Building Commissioner, other Town officials and the Applicant. Any modifications approved by the Board shall be made a permanent part of the approved project. Any plan modifications shall be shown on the final as-built plan.

14. ***Landscape Maintenance***
    a. Any shrubs, trees, bushes or other landscaping features shown on the Plan that die shall be replaced by the following spring.

    b. Within 60 days after two years after the occupancy permit is issued, the Town's Consulting Engineer or the Inspector of Buildings shall conduct an initial inspection of the landscaping to determine whether and which landscape items need replacement or removal and provide a report to the Board. At any time subsequent to this initial inspection, the Town's Consulting Engineer or the Inspector of Buildings may conduct further inspections of the landscaping to determine whether and which landscaping items need replacement or removal and provide a report to the Board. The Board may seek enforcement remedies with the Inspector of Buildings/Zoning Enforcement Officer to ensure that the comprehensive landscaping plan is maintained.

15. ***Project Completion*** – The Board shall determine project completion and refund/release the performance security once the applicant has completed the following tasks to the Board's satisfaction:

    a. provided the Board with written certification from a Professional Engineer registered in the Commonwealth of Massachusetts that all site work has been completed in substantial compliance with the approved and endorsed Plan, and any modifications thereto; and

    b. submitted an As-Built Construction Plan prepared by a registered Professional Land Surveyor or Engineer registered in the Commonwealth of Massachusetts in accordance with the *Subdivision Rules and Regulations* in effect at the time the plans are submitted to the Board for review by the Town's Consulting Engineer and the Board's approval. The Applicant shall provide the final as-built plan in CAD format compatible with the Medway GIS and acceptable to the Medway Board of Assessors (ArcInfo shape file - .shp).

    c. paid the Town of Medway for any taxes/fees associated with these parcels or other property owned by the applicant in the Town of Medway; and

    d. completed any mitigation measures specified in the subdivision certificate of action to the satisfaction of the Board.

VII. APPEAL

The Board and the Applicant have complied with all statutory requirements for the issuance of this Decision on the terms set forth herein. A copy of this Decision will be filed with the Medway Town Clerk and mailed to the Applicant, and notice will be mailed to all parties in interest.

Any person aggrieved by the decision of the Board may appeal to the appropriate court pursuant to Massachusetts General Laws, ch 41, § 81BB, which shall be filed within twenty days after the filing of this decision in the office of the Medway Town Clerk.

###

CHOATE TRAIL WAY DEFINITIVE SUBDIVISION PLAN
CERTIFICATE OF ACTION
MEDWAY PLANNING AND ECONOMIC DEVELOPMENT BOARD

Date of Action by the Medway Planning and Economic Development Board: ___________________

AYE:

NAY:

Attest: ____ ____________________
TBD

Attest: ____ ____________________
Susan E. Affleck-Childs Date
Planning and Economic Development Coordinator

Copies To:
Bob Pace, Residences at Choate Trail, LLC
David Spertner, Residences at Choate Trail, LLC
Matthew Silverstein, Residences at Choate Trail, LLC
Vito Colonna, Connorstone Engineering
Michael Boynton, Town Administrator
Stephanie Carlisle, DPW Compliance Officer
David D'Amico, DPW Director
Mike Fasolino, Deputy Fire Chief
Bridget Graziano, Conservation Agent
Donna Greenwood, Assessor
Beth Hallal, Health Agent
Jeff Lynch, Fire Chief
Jack Mee, Building Commissioner
Joanne Russo, Treasurer/Collector
Barbara Saint Andre, Community and Economic Development Director
Sergeant Jeffrey Watson, Police Safety Officer
Gino Carlucci, PGC Associates
Steve Bouley, Tetra Tech

Susan Affleck-Childs

From: Vito Colonna <vc@csei.net>
Sent: Tuesday, April 28, 2020 1:36 PM
To: Susan Affleck-Childs
Subject: Re: Choate Trail Subdivision

Susy,
I just had a couple items on the Draft Conditions to go over:

Applicant/Owner Address has changed to:
11 Tanglewood Drive
Nashua, NH 03062

Page 4, IV. 7.6.2 Underground Utilities: Related to locating a new pole on the project side of Highland versus installing an underground crossing Highland. I had thought at the last meeting there was no objection to the new pole and overhead across Highland. The applicant asked if this could this item be discussed further, but at the same time they don't want to hold things up.

VII Conditions: #8 Tree Preservation: We understand the scenic road regulations require the tree mitigation for any removal, however I hadn't found anything in the Sudvision reg's on the tree replacement due to future lot development. As the Board is aware the lot development typically is not finalized until they have a potential buyer, and the house layout (including limit of clearing) is subject to change. There is just concern that as the future lot development is finalized, there could be significant tree replacement cost if even one or two trees are removed. The number provided on the trees to be removed was an estimate. One possible alternative is to tie this tree preservation requirement to the trees >12" in the Selective Cut Zones.

Thank you,
Vito

From: Susan Affleck-Childs
Sent: Thursday, April 23, 2020 3:25 PM
To: Robert Pace ; David Spertner ; Matthew Silverstein
Cc: Vito Colonna
Subject: FW: Choate Trail Subdivision

Hi,

Hope everyone is well. Following up. Haven't heard back from anyone with questions or comments on the revised draft decision.

Please review and let me know.

Take care.

Best regards,

Susy Affleck-Childs

From: Susan Affleck-Childs
Sent: Thursday, April 09, 2020 4:04 PM
To: Robert Pace <rpace100@outlook.com>; David Spertner <dspertner@gmail.com>; Matthew Silverstein <silversm33@yahoo.com>
Cc: Vito Colonna <vc@csei.net>
Subject: Choate Trail Subdivision

Hi Bob,

The Medway Planning and Economic Development Board met Tuesday, April 7th. The meeting was held via ZOOM, a remote meeting platform that the Town is using during the COVID-19 state of emergency period. The continued hearing for the Choate Trail subdivision was on that agenda. However, no one from your team was "present". Therefore, the Board's had no choice but to continue the hearing.

You may be aware of recent legislation approved by the Legislature on April 2nd and signed by Governor Baker on April 3rd to address land use permitting deadlines during the COVID-19 pandemic. This legislation authorizes planning boards to reschedule public hearings to a date not more than 45 days after the termination of the state of emergency in Massachusetts. It also automatically tolls the action deadline requirements.

The Board has decided to exercise the authority granted to it to reschedule hearings and voted to continue the Choate Trail subdivision public hearing to May 12, 2020. This is the Board's next regular meeting date after the current COVID-19 state of emergency concludes on May 4, 2020. Of course, this may be adjusted if the state of emergency is extended.

In the meantime, I ask that you review the attached revised draft subdivision decision and get back in touch with me with any questions or comments.

Thank you for your understanding. Please don't hesitate to contact me.

Best regards,

Susy

Susan E. Affleck-Childs
Planning and Economic Development Coordinator
Town of Medway Public Schools 155 Village Street
Medway, MA 02053
508-533-3291

May 12, 2020

Medway Planning & Economic Development Board Meeting

Construction Reports

- William Wallace Village CO report #4 and 5 from March 19 and March 25, 2020
- Salmon ARCPUD CO reports #28 – 36 from November 12, 2019 through April 27, 2020

Tetra Tech
100 Nickerson Road, Suite 200
Marlborough, MA 01752

FIELD REPORT

Project	Date	Report No.
William Wallace Village	3/19/2020	4
Location	Project No.	Sheet 1 of
Village Street, Medway, MA	143-21583-19012	2
Contractor M. Phillips Industries (Site Contractor) Larry Rucci (Developer)	Weather A.M. P.M. CLOUDY	Temperature A.M. P.M. 45 ˚F

FIELD OBSERVATIONS

On Thursday March 19, 2020, Bradley M. Picard, E.I.T. from Tetra Tech (TT) visited the project location to inspect the current condition of the site and monitor construction progress. The following report outlines observations made during the site visit.

1. Observations

A. Contractor not on-site during inspection. General site conditions: Dry ground surface that is relatively firm throughout. Some puddles and soft spots present in areas throughout the site due to recent rainstorms. Standing water in the northeast portion of the site in excavated sediment basin. Construction entrance from Village Street is stabilized with crushed stone material, and additional crushed stone material has been installed at the entrance of the demolished bituminous lot adjacent to dwelling at 276 Village Street, no tracking of sediment was observed on Village Street. Stockpiles of excavated material and material from demolition are present throughout the site. Silt fence barrier (SFB) and compost filter tubes have been installed around the perimeter of the site, erosion controls appear to be in good condition.

B. Contractor is continuing demolition throughout the site and plans to continue for the next couple of weeks. Excavation for the footings at duplex Unit 1/Unit 2 appears to have been completed and crushed stone remains in the excavation presumably for proposed footing preparation.

CONTRACTOR'S FORCE AND EQUIPMENT						WORK DONE BY OTHERS	
Sup't	1	Bulldozer		Asphalt Paver		Dept. or Company	Description of Work
Foreman		Backhoe		Asphalt Reclaimer			
Laborers		Loader	1	Vib. Roller			
Drivers		Rubber Tire Backhoe/Loader		Static Roller			
Oper. Engr.	1	Skid Steer	1	Vib. Walk Comp.			
Carpenters		Hoeram		Compressor			
Masons		Excavator	1	Jack Hammer			
Iron Workers		Mini-Excavator	1	Power Saw			
Electricians		Grader		Conc. Vib.			
Flagpersons		Crane		Tack Truck			
Surveyors		Scraper		Man Lift			
Roofers		Conc. Mixer		Skidder		OFFICIAL VISITORS TO JOB	
Mechanical/HVAC		Conc. Truck		Compact Track Loader			
		Conc. Pump Truck		Porta-John	1		
		Pickup Truck	2	Dumpster (15 Yard)	1		
		Tri-Axle Dump Truck					
		Trailer Dump Truck					

Police Details: N/A	RESIDENT REPRESENTATIVE FORCE	
Contractor's Hours of Work: 7:00 A.M. to 6:00 P.M.	Name	Time on-site
	Bradley M. Picard, EIT	3:00 P.M. – 3:45 P.M..

NOTE: Please use reverse side for remarks and sketches

FIELD OBSERVATIONS CONTINUED

2. **Schedule**
   A. Contractor to continue prep for footings at duplex Unit 1/Unit 2.
   B. Contractor to continue stripping and stockpiling loam.
   C. TT will maintain communication with contractor and will inspect the site on an as-need basis.
3. **New Action Items**
   A. N/A
4. **Previous Open Action Items**
   A. Clean leaves and debris from basin at entrance to Bedelia Lane.
5. **Materials Delivered to Site Since Last Inspection**
   A. N/A

Tetra Tech
100 Nickerson Road, Suite 200
Marlborough, MA 01752

FIELD REPORT

Project	Date	Report No.
William Wallace Village	3/25/2020	5
Location	**Project No.**	**Sheet 1 of**
Village Street, Medway, MA	143-21583-19012	2
Contractor	**Weather**	**Temperature**
M. Phillips Industries (Site Contractor) Larry Rucci (Developer)	A.M. P.M. CLOUDY/RAIN	A.M. P.M. 40 ˚F

FIELD OBSERVATIONS

On Wednesday March 25, 2020, Bradley M. Picard, EIT from Tetra Tech (TT) visited the project location to inspect the current condition of the site and monitor construction progress. The following report outlines observations made during the site visit.

1. **Observations**

   A. Contractor not on-site during inspection. General site conditions: Dry ground surface that is relatively firm throughout. Some puddles and soft spots present in areas throughout the site due to recent rainstorms. Standing water in the northeast portion of the site in excavated sediment basin. Construction entrance from Village Street is stabilized with crushed stone material, and additional crushed stone material has been installed at the entrance of the demolished bituminous lot adjacent to dwelling at 276 Village Street, no tracking of sediment was observed on Village Street. Stockpiles of excavated material and material from demolition are present throughout the site. Silt fence barrier (SFB) and compost filter tubes have been installed around the perimeter of the site, some sections of SFB have fallen off of stakes on the east side of the site adjacent to the recently demolished volleyball court. Contractor to repair SFB that have fallen off stakes.

   B. Contactor has placed stakes on site laying out the proposed edge of pavement of the proposed driveway. Contractor's demolished material stockpiles, loam stockpiles, and tree stumps remain in the recently stripped portion of the site.

CONTRACTOR'S FORCE AND EQUIPMENT						WORK DONE BY OTHERS	
Sup't	1	Bulldozer		Asphalt Paver		Dept. or Company	Description of Work
Foreman		Backhoe		Asphalt Reclaimer			
Laborers		Loader	1	Vib. Roller			
Drivers		Rubber Tire Backhoe/Loader		Static Roller			
Oper. Engr.	1	Skid Steer	1	Vib. Walk Comp.			
Carpenters		Hoeram		Compressor			
Masons		Excavator	1	Jack Hammer			
Iron Workers		Mini-Excavator	1	Power Saw			
Electricians		Grader		Conc. Vib.			
Flagpersons		Crane		Tack Truck			
Surveyors		Scraper		Man Lift			
Roofers		Conc. Mixer		Skidder		OFFICIAL VISITORS TO JOB	
Mechanical/HVAC		Conc. Truck		Compact Track Loader			
		Conc. Pump Truck		Porta-John	1		
		Pickup Truck	2	Dumpster (15 Yard)	1		
		Tri-Axle Dump Truck					
		Trailer Dump Truck					
Police Details: 1						RESIDENT REPRESENTATIVE FORCE	
Contractor's Hours of Work: 7:00 A.M. to 6:00 P.M.						Name	Time on-site
						Bradley M. Picard, EIT	12:00 P.M. – 12:45 P.M..

NOTE: Please use reverse side for remarks and sketches

FIELD OBSERVATIONS CONTINUED

2. Schedule

A. Contractor to continue prep for footings at duplex Unit 1/Unit 2.

B. Contractor to continue stripping and stockpiling loam.

C. TT will maintain communication with contractor and will inspect the site on an as-need basis.

3. New Action Items

A. N/A

4. Previous Open Action Items

A. Clean leaves and debris from basin at entrance to Bedelia Lane.

5. Materials Delivered to Site Since Last Inspection

A. N/A

Tetra Tech 100 Nickerson Road, Suite 200 Marlborough, MA 01752	# FIELD REPORT	
Project Salmon Health and Retirement Community (The Willows)	Date 11/12/2019	Report No. 28
Location Village Street, Medway, MA	Project No. 143-21583-15011	Sheet 1 of 2
Contractor Rubicon Builders (General Contractor) Marois Brothers, Inc. (Site Contractor)	Weather A.M. P.M. CLOUDY/SNOW	Temperature A.M. P.M. 35˚F

FIELD OBSERVATIONS

On Tuesday, November 12, 2019, Bradley Picard, E.I.T. from Tetra Tech (TT) visited the project location to inspect the current condition of the site and observe construction progress. The report outlines observations made during the site visit.

1. **Observations**
   - A. General site conditions: The western portion of the site along Willow Pond Circle and the eastern portion of the site along Waterside Run are generally dry. The main open portion of the site is relatively dry and firm, some standing water and mud present from recent rain and heavy equipment activity. Construction entrances (Waterside Run and Willow Pond Circle) from Village Street are stabilized with crushed stone and rip-rap material and appear to be functioning as designed. Silt fence barrier (SFB) and filter socks appear to be in good condition throughout the site. Stockpiled soil and several disturbed areas on the site are stabilized with vegetative cover.
   - B. Contractor has started building the east side abutment for the bridge crossing on Waterside Run. Contractor is building the abutment using Versa Lok's Big Block Retaining Wall systems, geogrid has been placed between blocks then backfilled with stone and processed gravel. Drainage piping has been placed behind the wall.
   - C. Main campus building construction is ongoing, PERI SKYDECK slab forms have been installed at the west side of Building A. Footing preparation continues for Building B of the main campus, Contractor has excavated areas where footings will be constructed and placed 3/8" stone at the bottom of the excavations.
   - D. Vegetation continues developing along the slopes and the bottom of Basin 1 and Basin 3. Rip rap remains in good condition at each basin's forebay, emergency spillway, and outlet control structures. Both basins are dry upon inspection, TT will continue to monitor the condition and performance of the infiltration basins.

CONTRACTOR'S FORCE AND EQUIPMENT						WORK DONE BY OTHERS	
Sup't	1	Bulldozer	2	Asphalt Paver		Dept. or Company	Description of Work
Foreman	2	Backhoe		Asphalt Reclaimer		Raycon Construction, LLC	Concrete Construction
Laborers	5+	Loader	1	Vib. Roller	1	Mercier Electric Co.	Pull Cable Installation
Drivers		Rubber Tire Backhoe/Loader		Static Roller		Concrete Placement Inc.	Concrete Pumping
Oper. Engr.	3+	Skid Steer		Vib. Walk Comp.			
Carpenters		Hoeram		Compressor			
Masons		Excavator	3	Jack Hammer			
Iron Workers		Grader		Power Saw			
Electricians		Crane		Conc. Vib.			
Flagpersons		Scraper		Tack Truck			
Surveyors		Conc. Mixer		Man Lift			
		Conc. Truck		Skidder		OFFICIAL VISITORS TO JOB	
		Conc. Pump Truck	1	Compact Track Loader			
		Pickup Truck	5+	Water Truck	1		
		Tri-Axle Dump Truck	5+	Crane Truck	1		
		Trailer Dump Truck					
		Art. Dump Truck					
Police Details: N/A						RESIDENT REPRESENTATIVE FORCE	
Contractor's Hours of Work: 7:00 A.M. to 3:30 P.M.						Name	Time on-site
						Bradley M. Picard, EIT	1:30 A.M. – 2:30 P.M.

NOTE: Please use reverse side for remarks and sketches

TETRA TECH

FIELD OBSERVATIONS CONTINUED

2. **Schedule**
   A. Contractor plans to continue filling of site to achieve proposed grades.
   B. Contractor will continue main campus building construction.
   C. Contractor will continue installing sewer, drainage, and electrical utilities throughout the site.
   D. TT will maintain communication with contractor and will inspect the site as construction progresses.
3. **New Action Items**
   A. N/A
4. **Previous Open Action Items**
   A. N/A
5. **Materials Delivered to Site Since Last Inspection**
   A. N/A

Tetra Tech
100 Nickerson Road, Suite 200
Marlborough, MA 01752

FIELD REPORT

Project	Date	Report No.
Salmon Health and Retirement Community (The Willows)	01/14/2020	29
Location	Project No.	Sheet 1 of
Village Street, Medway, MA	143-21583-15011	2
Contractor	Weather	Temperature
Rubicon Builders (General Contractor) Marois Brothers, Inc. (Site Contractor)	A.M. P.M. OVERCAST	A.M. P.M. 40˚F

FIELD OBSERVATIONS

On Tuesday, January 14, 2020, Bradley Picard, E.I.T. from Tetra Tech (TT) visited the project location to inspect the current condition of the site and observe construction progress. The report outlines observations made during the site visit.

1. Observations

A. General site conditions: The western portion of the site along Willow Pond Circle and the eastern portion of the site along Waterside Run are generally dry. The main open portion of the site is relatively dry and firm, some standing water and mud present from snowmelt and heavy equipment activity. Construction entrances (Waterside Run and Willow Pond Circle) from Village Street are stabilized with crushed stone and rip-rap material and appear to be functioning as designed. Silt fence barrier (SFB) and filter socks appear to be in good condition throughout the site. Stockpiled soil and several disturbed areas on the site are stabilized with vegetative cover.

B. Contractor continues bridge crossing construction on Waterside Run. Bridge span is made of timber, utilities (electrical, telecom, sewer force main, water main) have been brought over the wetland towards the central campus area on Willow Pond Circle. Insulation is present surrounding the sewer force main and water main.

C. Main campus building construction is ongoing, timber construction is ongoing at the west side of Building A, and PERI SKYDECK slab forms have been installed at the east side of Building A. Footing preparation continues for Building C of the main campus, Contractor has excavated areas where footings will be constructed and placed 3/8" stone at the bottom of the excavations. Steel construction is ongoing for Building B.

CONTRACTOR'S FORCE AND EQUIPMENT						WORK DONE BY OTHERS	
Sup't	1	Bulldozer	2	Asphalt Paver		Dept. or Company	Description of Work
Foreman	2+	Backhoe		Asphalt Reclaimer		Raycon Construction, LLC	Concrete Construction
Laborers	5+	Loader	1	Vib. Roller	1	Mercier Electric Co.	Pull Cable Installation
Drivers		Rubber Tire Backhoe/Loader		Static Roller		Concrete Placement Inc.	Concrete Pumping
Oper. Engr.	3+	Skid Steer		Vib. Walk Comp.			
Carpenters		Hoeram		Compressor			
Masons		Excavator	3	Jack Hammer			
Iron Workers		Grader		Power Saw			
Electricians		Crane		Conc. Vib.			
Flagpersons		Scraper		Tack Truck			
Surveyors		Conc. Mixer		Man Lift			
		Conc. Truck		Skidder		OFFICIAL VISITORS TO JOB	
		Conc. Pump Truck		Compact Track Loader			
		Pickup Truck	5+	Water Truck			
		Tri-Axle Dump Truck		Crane Truck			
		Trailer Dump Truck		Lull	2		
		Art. Dump Truck					

Police Details: N/A	RESIDENT REPRESENTATIVE FORCE	
Contractor's Hours of Work: 7:00 A.M. to 3:30 P.M.	Name	Time on-site
	Bradley M. Picard, EIT	2:00 P.M. – 2:30 P.M.

NOTE: Please use reverse side for remarks and sketches

FIELD OBSERVATIONS CONTINUED

2. **Schedule**
   A. Contractor will continue main campus building construction.
   B. Contractor will continue bridge construction on the east side of the site.
   C. Contractor will continue installing sewer, drainage, and electrical utilities throughout the site.
   D. TT will maintain communication with contractor and will inspect the site as construction progresses.
3. **New Action Items**
   A. N/A
4. **Previous Open Action Items**
   A. N/A
5. **Materials Delivered to Site Since Last Inspection**
   A. N/A

Tetra Tech
100 Nickerson Road, Suite 200
Marlborough, MA 01752

FIELD REPORT

Project	Date	Report No.
Salmon Health and Retirement Community (The Willows)	03/31/2020	30
Location	**Project No.**	**Sheet 1 of**
Village Street, Medway, MA	143-21583-15011	2
Contractor	**Weather**	**Temperature**
Rubicon Builders (General Contractor) Marois Brothers, Inc. (Site Contractor)	A.M. P.M. OVERCAST	A.M. P.M. 40˚F

FIELD OBSERVATIONS

On Tuesday, March 31, 2020, Bradley Picard, E.I.T. from Tetra Tech (TT) visited the project location to inspect the current condition of the site and observe construction progress. The report outlines observations made during the site visit.

1. **Observations**
   A. General site conditions: The western portion of the site along Willow Pond Circle is generally dry. The main open portion of the site is relatively dry and firm, some standing water and mud present from recent rainstorms and heavy equipment activity. Construction entrances from Village Street are stabilized with crushed stone and rip-rap material and appear to be functioning as designed. All traffic is directed to the construction entrance on the west side of the site (Willow Pond Circle). Silt fence barrier (SFB) and filter socks appear to be in good condition. Stockpiled soil is present throughout the main open portion of the site.

   B. TT on site to inspect the construction of Infiltration Trench 16 located on the east side of the main campus building. Upon arrival, contractor had excavated the first 20 feet on the western portion of Infiltration Trench 16 down to the elevation of the top of the drainage wick. Contractor has also exposed end of roof drain pipes that will be connected to the infiltration system. As excavation bottom is reached, crushed stone is being placed inside of the excavated trench to provide 12" compacted bedding for chambers. Proposed elevations (i.e. bottom of trench, top of stone bedding) are determined in the field using self-leveling rotary laser and associated receiver. Prior to chamber installation, contractor has installed a strip of scour protection geotextile on top of the stone bedding along the inlet side of the infiltration system per the manufacturer's installation guidelines. Following scour protection installation, StormKeeper SK75 chambers were installed manually, making seven rows of chambers that will extend the length of the trench. Upon departure, contractor has installed one chamber in each row (seven chambers total) and started backfilling chambers with crushed stone to proposed top of stone elevations.

CONTRACTOR'S FORCE AND EQUIPMENT						WORK DONE BY OTHERS	
Sup't	1	Bulldozer		Asphalt Paver		Dept. or Company	Description of Work
Foreman	1	Backhoe		Asphalt Reclaimer		Raycon Construction, LLC	Concrete Construction
Laborers	2	Loader	1	Vib. Roller	1	Mercier Electric Co.	Pull Cable Installation
Drivers		Rubber Tire Backhoe/Loader		Static Roller		Concrete Placement Inc.	Concrete Pumping
Oper. Engr.	2	Skid Steer		Vib. Walk Comp.	1		
Carpenters		Hoeram		Compressor			
Masons		Excavator	3	Jack Hammer			
Iron Workers		Grader		Power Saw			
Electricians		Crane		Conc. Vib.			
Flagpersons		Scraper		Tack Truck			
Surveyors		Conc. Mixer		Man Lift			
		Conc. Truck		Skidder		OFFICIAL VISITORS TO JOB	
		Conc. Pump Truck		Compact Track Loader			
		Pickup Truck	5+	Water Truck			
		Tri-Axle Dump Truck		Crane Truck			
		Trailer Dump Truck		Lull	2		
		Art. Dump Truck					

	RESIDENT REPRESENTATIVE FORCE	
Police Details: N/A		
Contractor's Hours of Work: 7:00 A.M. to 3:30 P.M.	Name	Time on-site
	Bradley M. Picard, EIT	2:00 P.M. – 2:30 P.M.

NOTE: Please use reverse side for remarks and sketches

FIELD OBSERVATIONS CONTINUED

2. Schedule

A. Contractor will continue main campus building construction.

B. Contractor will continue installation of Infiltration Trench 16.

C. TT will maintain communication with contractor and will inspect the site as construction progresses.

3. New Action Items

A. N/A

4. Previous Open Action Items

A. N/A

5. Materials Delivered to Site Since Last Inspection

A. Crushed stone for infiltration trench.

B. Various building materials for main campus building.

Tetra Tech 100 Nickerson Road, Suite 200 Marlborough, MA 01752	FIELD REPORT	
Project Salmon Health and Retirement Community (The Willows)	Date 04/01/2020	Report No. 31
Location Village Street, Medway, MA	Project No. 143-21583-15011	Sheet 1 of 2
Contractor Rubicon Builders (General Contractor) Marois Brothers, Inc. (Site Contractor)	Weather A.M. P.M. OVERCAST	Temperature A.M. P.M. 40˚F

FIELD OBSERVATIONS

On Wednesday, April 1, 2020, Bradley Picard, E.I.T. from Tetra Tech (TT) visited the project location to inspect the current condition of the site and observe construction progress. The report outlines observations made during the site visit.

1. **Observations**
   A. General site conditions: The western portion of the site along Willow Pond Circle is generally dry. The main open portion of the site is relatively dry and firm, some standing water and mud present from recent rainstorms and heavy equipment activity. Construction entrances from Village Street are stabilized with crushed stone and rip-rap material and appear to be functioning as designed. All traffic is directed to the construction entrance on the west side of the site (Willow Pond Circle). Silt fence barrier (SFB) and filter socks appear to be in good condition. Stockpiled soil is present throughout the main open portion of the site.

   B. TT on site to inspect the construction of Infiltration Trench 16 located on the east side of the main campus building. Upon arrival, contractor in the process of excavating the remaining portions of the trench. Contractor had installed seven PVC inspection ports on the west side of the infiltration system. As excavation bottom is reached, crushed stone is being placed inside of the excavated trench to provide 12” compacted bedding for chambers. StormKeeper SK75 chambers were installed manually as stone bedding is compacted. Contractor had determined the location to install the drainage wick inspection port, and installed a capped, perforated, 4” schedule 40 PVC pipe to the bottom of the wick. Perforated pipe extends up to the top of stone elevation. Upon departure, Contractor continues to place nonwoven geotextile around the sides of the excavation, place crushed stone into the trench, and install chambers.

CONTRACTOR’S FORCE AND EQUIPMENT						WORK DONE BY OTHERS	
Sup’t	1	Bulldozer		Asphalt Paver		Dept. or Company	Description of Work
Foreman	1	Backhoe		Asphalt Reclaimer		Raycon Construction, LLC	Concrete Construction
Laborers	2	Loader	1	Vib. Roller	1	Mercier Electric Co.	Pull Cable Installation
Drivers		Rubber Tire Backhoe/Loader		Static Roller		Concrete Placement Inc.	Concrete Pumping
Oper. Engr.	2	Skid Steer		Vib. Walk Comp.	1		
Carpenters		Hoeram		Compressor			
Masons		Excavator	3	Jack Hammer			
Iron Workers		Grader		Power Saw			
Electricians		Crane		Conc. Vib.			
Flagpersons		Scraper		Tack Truck			
Surveyors		Conc. Mixer		Man Lift			
		Conc. Truck		Skidder		OFFICIAL VISITORS TO JOB	
		Conc. Pump Truck		Compact Track Loader			
		Pickup Truck	5+	Water Truck			
		Tri-Axle Dump Truck		Crane Truck			
		Trailer Dump Truck		Lull	2		
		Art. Dump Truck					
Police Details: N/A						RESIDENT REPRESENTATIVE FORCE	
Contractor’s Hours of Work: 7:00 A.M. to 3:30 P.M.						Name	Time on-site
						Bradley M. Picard, EIT	1:00 P.M. – 2:30 P.M.

NOTE: Please use reverse side for remarks and sketches

FIELD OBSERVATIONS CONTINUED

2. Schedule

A. Contractor will continue main campus building construction.

B. Contractor will continue installation of Infiltration Trench 16.

C. TT will maintain communication with contractor and will inspect the site as construction progresses.

3. New Action Items

A. N/A

4. Previous Open Action Items

A. N/A

5. Materials Delivered to Site Since Last Inspection

A. N/A

Tetra Tech
100 Nickerson Road, Suite 200
Marlborough, MA 01752

FIELD REPORT

Project	Date	Report No.
Salmon Health and Retirement Community (The Willows)	04/02/2020	32
Location	**Project No.**	**Sheet 1 of**
Village Street, Medway, MA	143-21583-15011	2
Contractor	**Weather**	**Temperature**
Rubicon Builders (General Contractor) Marois Brothers, Inc. (Site Contractor)	A.M. OVERCAST P.M.	A.M. 40˚F P.M.

FIELD OBSERVATIONS

On Thursday, April 2, 2020, Bradley Picard, E.I.T. from Tetra Tech (TT) visited the project location to inspect the current condition of the site and observe construction progress. The report outlines observations made during the site visit.

1. **Observations**
   A. General site conditions: The western portion of the site along Willow Pond Circle is generally dry. The main open portion of the site is relatively dry and firm, some standing water and mud present from recent rainstorms and heavy equipment activity. Construction entrances from Village Street are stabilized with crushed stone and rip-rap material and appear to be functioning as designed. All traffic is directed to the construction entrance on the west side of the site (Willow Pond Circle). Silt fence barrier (SFB) and filter socks appear to be in good condition. Stockpiled soil is present throughout the main open portion of the site.

   B. TT on site to inspect the construction of Infiltration Trench 16 located on the east side of the main campus building. Upon arrival, contractor had completed installation of 77 StormKeeper SK75 chambers and backfilled chambers with crushed stone. Inspection ports have been installed on the eastern side of the infiltration trench, and a solid section of PVC pipe has been installed on the drainage wick inspection port in the area where soil will be placed. Contractor had wrapped stone above the chambers with non-woven geotextile material and added additional stone to the top of the geotextile fabric. Contractor then placed woven geotextile material above the stone to provide additional reinforcement to the system as it will be under a parking lot. Stone will then be placed over the geotextile material, followed by gravel backfilled to current fill elevations.

CONTRACTOR'S FORCE AND EQUIPMENT						WORK DONE BY OTHERS	
Sup't	1	Bulldozer		Asphalt Paver		Dept. or Company	Description of Work
Foreman	1	Backhoe		Asphalt Reclaimer		Raycon Construction, LLC	Concrete Construction
Laborers	2	Loader	1	Vib. Roller	1	Mercier Electric Co.	Pull Cable Installation
Drivers		Rubber Tire Backhoe/Loader		Static Roller		Concrete Placement Inc.	Concrete Pumping
Oper. Engr.	2	Skid Steer		Vib. Walk Comp.	1		
Carpenters		Hoeram		Compressor			
Masons		Excavator	3	Jack Hammer			
Iron Workers		Grader		Power Saw			
Electricians		Crane		Conc. Vib.			
Flagpersons		Scraper		Tack Truck			
Surveyors		Conc. Mixer		Man Lift			
		Conc. Truck		Skidder		OFFICIAL VISITORS TO JOB	
		Conc. Pump Truck		Compact Track Loader			
		Pickup Truck	5+	Water Truck			
		Tri-Axle Dump Truck		Crane Truck			
		Trailer Dump Truck		Lull	2		
		Art. Dump Truck					

Police Details: N/A	RESIDENT REPRESENTATIVE FORCE	
Contractor's Hours of Work: 7:00 A.M. to 3:30 P.M.	Name	Time on-site
	Bradley M. Picard, EIT	10:00 A.M. – 11:00 A.M.

NOTE: Please use reverse side for remarks and sketches

FIELD OBSERVATIONS CONTINUED

2. **Schedule**
   A. Contractor will continue main campus building construction.
   B. Contractor to begin construction of Infiltration Trench 20 within the next 2 weeks.
   C. TT will maintain communication with contractor and will inspect the site as construction progresses.
3. **New Action Items**
   A. N/A
4. **Previous Open Action Items**
   A. N/A
5. **Materials Delivered to Site Since Last Inspection**
   A. N/A

Tetra Tech 100 Nickerson Road, Suite 200 Marlborough, MA 01752	# FIELD REPORT	
Project Salmon Health and Retirement Community (The Willows)	Date 04/22/2020	Report No. 33
Location Village Street, Medway, MA	Project No. 143-21583-15011	Sheet 1 of 2
Contractor Rubicon Builders (General Contractor) Marois Brothers, Inc. (Site Contractor)	Weather A.M. P.M. OVERCAST	Temperature A.M. P.M. 40˚F

FIELD OBSERVATIONS

On Wednesday, April 22, 2020, Bradley Picard, E.I.T. from Tetra Tech (TT) visited the project location to inspect the current condition of the site and observe construction progress. The report outlines observations made during the site visit.

1. **Observations**
   A. General site conditions: The western portion of the site along Willow Pond Circle is generally dry. The main open portion of the site is relatively dry and firm, some standing water and mud present from recent rainstorms and heavy equipment activity. Construction entrances from Village Street are stabilized with crushed stone and rip-rap material and appear to be functioning as designed. All traffic is directed to the construction entrance on the west side of the site (Willow Pond Circle). Silt fence barrier (SFB) and filter socks appear to be in good condition. Stockpiled construction materials, crushed stone, and soil are present throughout the main open portion of the site.
   B. TT on site to inspect the construction of Infiltration Trench 20 located on the west side of the main campus building. Upon arrival, contractor had excavated the first 25 feet on the southern portion of Infiltration Trench 20 down to the elevation of the top of the drainage wick. Contractor will be moving in a south-to-north direction excavating the trench. As excavation bottom is reached, crushed stone is being placed inside of the excavated trench to provide 12” bedding for chambers. Proposed elevations (i.e. bottom of trench, top of stone bedding) are determined in the field using self-leveling rotary laser and associated receiver. Sides of excavated trench are lined with non-woven geotextile material.

CONTRACTOR’S FORCE AND EQUIPMENT						WORK DONE BY OTHERS	
Sup’t	1	Bulldozer		Asphalt Paver		Dept. or Company	Description of Work
Foreman	1	Backhoe		Asphalt Reclaimer		Raycon Construction, LLC	Concrete Construction
Laborers	2	Loader	1	Vib. Roller	1	Mercier Electric Co.	Pull Cable Installation
Drivers		Rubber Tire Backhoe/Loader		Static Roller		Concrete Placement Inc.	Concrete Pumping
Oper. Engr.	1	Skid Steer		Vib. Walk Comp.	1		
Carpenters		Hoeram		Compressor			
Masons		Excavator	3	Jack Hammer			
Iron Workers		Grader		Power Saw			
Electricians		Crane		Conc. Vib.			
Flagpersons		Scraper		Tack Truck			
Surveyors		Conc. Mixer		Man Lift			
		Conc. Truck		Skidder		OFFICIAL VISITORS TO JOB	
		Conc. Pump Truck		Compact Track Loader			
		Pickup Truck	5+	Water Truck			
		Tri-Axle Dump Truck		Crane Truck			
		Trailer Dump Truck		Lull	2		
		Art. Dump Truck					
Police Details: N/A						RESIDENT REPRESENTATIVE FORCE	
Contractor’s Hours of Work: 7:00 A.M. to 3:30 P.M.						Name	Time on-site
						Bradley M. Picard, EIT	12:00 P.M. – 12:30 P.M.

NOTE: Please use reverse side for remarks and sketches

FIELD OBSERVATIONS CONTINUED

2. **Schedule**
   A. Contractor will continue main campus building construction.
   B. Contractor will continue installation of Infiltration Trench 20.
   C. TT will maintain communication with contractor and will inspect the site as construction progresses.
3. **New Action Items**
   A. N/A
4. **Previous Open Action Items**
   A. N/A
5. **Materials Delivered to Site Since Last Inspection**
   A. Crushed stone for infiltration trench.
   B. Various building materials for main campus building.

Tetra Tech
100 Nickerson Road, Suite 200
Marlborough, MA 01752

FIELD REPORT

Project	Date	Report No.
Salmon Health and Retirement Community (The Willows)	04/23/2020	34
Location	**Project No.**	**Sheet 1 of**
Village Street, Medway, MA	143-21583-15011	2
Contractor	**Weather**	**Temperature**
Rubicon Builders (General Contractor) Marois Brothers, Inc. (Site Contractor)	A.M. P.M. OVERCAST	A.M. P.M. 40˚F

FIELD OBSERVATIONS

On Thursday, April 23, 2020, Bradley Picard, E.I.T. from Tetra Tech (TT) visited the project location to inspect the current condition of the site and observe construction progress. The report outlines observations made during the site visit.

1. Observations

A. General site conditions: The western portion of the site along Willow Pond Circle is generally dry. The main open portion of the site is relatively dry and firm, some standing water and mud present from recent rainstorms and heavy equipment activity. Construction entrances from Village Street are stabilized with crushed stone and rip-rap material and appear to be functioning as designed. All traffic is directed to the construction entrance on the west side of the site (Willow Pond Circle). Silt fence barrier (SFB) and filter socks appear to be in good condition. Stockpiled construction materials, crushed stone, and soil are present throughout the main open portion of the site.

B. TT on site to inspect the construction of Infiltration Trench 20 located on the west side of the main campus building. Upon arrival, contractor had completed excavation of the trench to the elevation of the top of the drainage wick. Crushed stone is being placed inside of the excavated trench to provide 12” compacted bedding for chambers. Proposed elevations (i.e. bottom of trench, top of stone bedding) are determined in the field using self-leveling rotary laser and associated receiver. Sides of excavated trench are lined with non-woven geotextile material. Contractor is installing Stormkeeper SK75 chambers on the south and east side of the trench, backfilling chambers with crushed stone to proposed top of stone elevations. Contractor is concerned that due to recently installed utilities and future foundation installations for recreational spaces, four chambers will be unable to be installed in the system. TT advised the contractor to find space for all the chambers proposed in the system to ensure the system operates as designed and system capacity is not reduced. It was also stated to the contractor that all correspondence regarding system design should be directed to the design engineer’s team.

CONTRACTOR’S FORCE AND EQUIPMENT						WORK DONE BY OTHERS	
Sup’t	1	Bulldozer		Asphalt Paver		Dept. or Company	Description of Work
Foreman	1	Backhoe		Asphalt Reclaimer		Raycon Construction, LLC	Concrete Construction
Laborers	2	Loader	1	Vib. Roller	1	Mercier Electric Co.	Pull Cable Installation
Drivers		Rubber Tire Backhoe/Loader		Static Roller			
Oper. Engr.	1	Skid Steer		Vib. Walk Comp.	1		
Carpenters		Hoeram		Compressor			
Masons		Excavator	3	Jack Hammer			
Iron Workers		Grader		Power Saw			
Electricians		Crane		Conc. Vib.			
Flagpersons		Scraper		Tack Truck			
Surveyors		Conc. Mixer		Man Lift			
		Conc. Truck		Skidder		OFFICIAL VISITORS TO JOB	
		Conc. Pump Truck		Compact Track Loader			
		Pickup Truck	5+	Water Truck			
		Tri-Axle Dump Truck		Crane Truck			
		Trailer Dump Truck		Lull	2		
		Art. Dump Truck					

Police Details: N/A	RESIDENT REPRESENTATIVE FORCE	
Contractor’s Hours of Work: 7:00 A.M. to 3:30 P.M.	Name	Time on-site
	Bradley M. Picard, EIT	2:00 P.M. – 3:00 P.M.

NOTE: Please use reverse side for remarks and sketches

FIELD OBSERVATIONS CONTINUED

TT discussed with the contractor the location of the wick inspection port, contractor will install a capped, perforated, 4” schedule 40 PVC pipe to the bottom of the wick. Perforated pipe will extend to the top of stone elevation, and solid pipe will extend through the non-stone strata to prevent soil from entering the inspection port.

2. **Schedule**
   A. Contractor will continue main campus building construction.
   B. Contractor will continue installation of Infiltration Trench 20.
   C. TT will maintain communication with contractor and will inspect the site as construction progresses.
3. **New Action Items**
   A. N/A
4. **Previous Open Action Items**
   A. N/A
5. **Materials Delivered to Site Since Last Inspection**
   A. Crushed stone for infiltration trench.

Tetra Tech
100 Nickerson Road, Suite 200
Marlborough, MA 01752

FIELD REPORT

Project	Date	Report No.
Salmon Health and Retirement Community (The Willows)	04/24/2020	35
Location	**Project No.**	**Sheet 1 of**
Village Street, Medway, MA	143-21583-15011	2
Contractor	**Weather**	**Temperature**
Rubicon Builders (General Contractor) Marois Brothers, Inc. (Site Contractor)	A.M. P.M. OVERCAST/RAIN	A.M. P.M. 40˚F

FIELD OBSERVATIONS

On Friday, April 24, 2020, Bradley Picard, E.I.T. from Tetra Tech (TT) visited the project location to inspect the current condition of the site and observe construction progress. The report outlines observations made during the site visit.

1. Observations

A. General site conditions: The western portion of the site along Willow Pond Circle is generally dry. The main open portion of the site is relatively dry and firm, some standing water and mud present from recent rainstorms and heavy equipment activity. Construction entrances from Village Street are stabilized with crushed stone and rip-rap material and appear to be functioning as designed. All traffic is directed to the construction entrance on the west side of the site (Willow Pond Circle). Silt fence barrier (SFB) and filter socks appear to be in good condition. Stockpiled construction materials, crushed stone, and soil are present throughout the main open portion of the site.

B. TT on site to inspect the construction of Infiltration Trench 20 located on the west side of the main campus building. Upon arrival, contractor nears completion of chamber installation. Additional excavation is necessary to fit final four Stormkeeper SK75 chambers on the northeast portion of the infiltration system, chamber install to be completed Monday morning (4/27). Coneco was on-site to perform erosion control inspection, TT and Contractor made engineer aware that final four chambers will be installed Monday. Sides of excavated trench are lined with non-woven geotextile material, geotextile is also wrapped on top of 6" layer of crushed stone backfill above chambers. Contractor is also placing four inches of stone above geotextile material, followed by installation of a second layer of non-woven geotextile material to provide additional reinforcement in the event of construction vehicles traveling over the system. Contractor has installed wick inspection port at the center of the system, TT measured depth of inspection port and determined the wick reaches the bottom of system.

CONTRACTOR'S FORCE AND EQUIPMENT						WORK DONE BY OTHERS	
Sup't	1	Bulldozer		Asphalt Paver		Dept. or Company	Description of Work
Foreman	1	Backhoe		Asphalt Reclaimer		Raycon Construction, LLC	Concrete Construction
Laborers	2	Loader	1	Vib. Roller	1	Mercier Electric Co.	Pull Cable Installation
Drivers		Rubber Tire Backhoe/Loader		Static Roller			
Oper. Engr.	1	Skid Steer		Vib. Walk Comp.	1		
Carpenters		Hoeram		Compressor			
Masons		Excavator	3	Jack Hammer			
Iron Workers		Grader		Power Saw			
Electricians		Crane		Conc. Vib.			
Flagpersons		Scraper		Tack Truck			
Surveyors		Conc. Mixer		Man Lift			
		Conc. Truck		Skidder		OFFICIAL VISITORS TO JOB	
		Conc. Pump Truck		Compact Track Loader			
		Pickup Truck	5+	Water Truck			
		Tri-Axle Dump Truck		Crane Truck			
		Trailer Dump Truck		Lull	2		
		Art. Dump Truck					

Police Details: N/A	RESIDENT REPRESENTATIVE FORCE	
Contractor's Hours of Work: 7:00 A.M. to 3:30 P.M.	Name	Time on-site
	Bradley M. Picard, EIT	12:30 P.M. – 1:15 P.M.

NOTE: Please use reverse side for remarks and sketches

FIELD OBSERVATIONS CONTINUED

2. **Schedule**
   A. Contractor will continue main campus building construction.
   B. Contractor will continue installation of chambers at Infiltration Trench 20.
   C. TT will maintain communication with contractor and will inspect the site as construction progresses.
3. **New Action Items**
   A. N/A
4. **Previous Open Action Items**
   A. N/A
5. **Materials Delivered to Site Since Last Inspection**
   A. N/A

Tetra Tech
100 Nickerson Road, Suite 200
Marlborough, MA 01752

FIELD REPORT

Project	Date	Report No.
Salmon Health and Retirement Community (The Willows)	04/27/2020	36
Location	**Project No.**	**Sheet 1 of**
Village Street, Medway, MA	143-21583-15011	2
Contractor	**Weather**	**Temperature**
Rubicon Builders (General Contractor) Marois Brothers, Inc. (Site Contractor)	A.M. OVERCAST/RAIN P.M. OVERCAST/RAIN	A.M. 35˚F P.M. 40˚F

FIELD OBSERVATIONS

On Monday, April 27, 2020, Bradley Picard, E.I.T. from Tetra Tech (TT) visited the project location to inspect the current condition of the site and observe construction progress. The report outlines observations made during the site visit.

1. **Observations**

   A. General site conditions: The western portion of the site along Willow Pond Circle is generally dry, some puddles and mud present from recent rainstorms and traffic entering and exiting the site. The main open portion of the site is firm, standing water and mud present from recent rainstorms and heavy equipment activity. Construction entrances from Village Street are stabilized with crushed stone and rip-rap material and appear to be functioning as designed. All traffic is directed to the construction entrance on the west side of the site (Willow Pond Circle). Silt fence barrier (SFB) and filter socks appear to be in good condition. Stockpiled construction materials, crushed stone, and soil are present throughout the main open portion of the site.

   B. TT on site to inspect the construction of Infiltration Trench 20 located on the west side of the main campus building. Upon arrival, contractor is in the process of wrapping infiltration system with geotextile material. Contractor is wrapping system starting from the west and working east. Non-woven geotextile placed on top of 6" layer of crushed stone backfill per the Plan. To provide additional protection of the system, Contractor installing four inches of stone above geotextile material, followed by installation of an additional layer of non-woven geotextile material. Contractor placed processed gravel above wrapped system and compacted to current fill elevations using a BOMAG remote compactor.

   C. Contractor extended northeast portion of trench to provide necessary space to install final four SK75 chambers, 158 total chambers installed for Infiltration Trench 20. Sides of excavation covered with non-woven geotextile material. Crushed stone bedding, SK75 chamber install, and backfill materials placed per the Plan.

CONTRACTOR'S FORCE AND EQUIPMENT						WORK DONE BY OTHERS	
Sup't	1	Bulldozer		Asphalt Paver		Dept. or Company	Description of Work
Foreman	1	Backhoe		Asphalt Reclaimer		Raycon Construction, LLC	Concrete Construction
Laborers	2	Loader	1	Vib. Roller	1	Mercier Electric Co.	Pull Cable Installation
Drivers		Rubber Tire Backhoe/Loader		Static Roller			
Oper. Engr.	1	Skid Steer		Vib. Walk Comp.	1		
Carpenters		Hoeram		Compressor			
Masons		Excavator	2	Jack Hammer			
Iron Workers		Grader		Power Saw			
Electricians		Crane		Conc. Vib.			
Flagpersons		Scraper		Tack Truck			
Surveyors		Conc. Mixer		Man Lift			
		Conc. Truck		Skidder		OFFICIAL VISITORS TO JOB	
		Conc. Pump Truck		Compact Track Loader			
		Pickup Truck	5+	Water Truck			
		Tri-Axle Dump Truck		Crane Truck			
		Trailer Dump Truck		Lull	2		
		Art. Dump Truck		BOMAG Remote Comp.	1		

Police Details: N/A	RESIDENT REPRESENTATIVE FORCE	
Contractor's Hours of Work: 7:00 A.M. to 3:30 P.M.	Name	Time on-site
	Bradley M. Picard, EIT	9:00 A.M. – 2:00 P.M.

NOTE: Please use reverse side for remarks and sketches

FIELD OBSERVATIONS CONTINUED

2. Schedule

A. Contractor will continue main campus building construction.

B. TT will maintain communication with contractor and will inspect the site as construction progresses.

3. New Action Items

A. Contractor to provide photos from wick inspection port installation to ensure inspection port reaches bottom of wick and to confirm proper materials were used.

4. Previous Open Action Items

A. N/A

5. Materials Delivered to Site Since Last Inspection

A. N/A

May 12, 2020

Medway Planning & Economic Development Board Meeting

<u>ZBA Petition – Accessory Family Dwelling Unit Special Permit 18 Broad Acres Farm Road</u>

- AFDU special permit application for 18 Broad Acres Farm Road.

NOTE – This is for a free-standing AFDU. 880 sq. ft. plus garage. I believe this may be the first application for a free-standing dwelling separate from the main house. The ZBA hearing is scheduled for Wednesday, June 3, 2020.

GENERAL APPLICATION FORM

TOWN OF MEDWAY

ZONING BOARD OF APPEALS

155 Village Street
Medway MA 02053

Phone: 508-321-4915 | zoning@townofmedway.org
www.townofmedway.org/zoning-board-appeal

NOTE: THE APPLICATION WILL NOT BE CONSIDERED "COMPLETE" UNLESS ALL NECESSARY DOCUMENTS, FEES, & WAIVER REQUESTS ARE SUBMITTED. A GENERAL APPLICATION FORM MUST BE COMPLETED FOR ALL APPLICATIONS.

TO BE COMPLETED BY THE APPLICANT

Applicant/Petitioner(s): Justin & Jennifer Smith	**Application Request(s):**
Property Owner(s): Justin & Jennifer Smith	Appeal ☐
	Special Permit ☑
Site Address(es): 18 Broad Acres Farm Rd, Medway MA	Variance ☐
	Determination/Finding ☐
	Extension ☐
	Modification ☐
Parcel ID(s): 19-003	Comprehensive Permit ☐
Zoning District(s): AR-I	

Registry of Deeds Book & Page No. and Date or Land Court Certificate No. and Date of Current Title:
Book 32681 pg 556 (Plan No 829 of 1999 in Plan Bk 471)

TOWN CLERK STAMP

TO BE COMPLETED BY STAFF:

Check No.:

Date of Complete Submittal:

Comments:

Received by: ________ Date: ________

APPLICANT/PETITIONER INFORMATION

The owner(s) of the land must be included as an applicant, even if not the proponent. Persons or entities other than the owner may also serve as co-applicants in addition to the owner(s), however, in each instance, such person shall provide sufficient written evidence of authority to act on behalf of the owner(s). For legal entities such as corporations, LLCs, etc., list the type and legal status of ownership, the name of the trustees/officer members, their affiliation, and contact information. Please provide attachment for information if necessary.

Applicant/Petitioner(s): Justin & Jennifer Smith	Phone: 239-560-2322
	Email: justin@sunwestsales.com
Address: 18 Broad Acres, Medway, MA 02053	
Attorney/Engineer/Representative(s): Colonial Engineering, Inc.	Phone: 508-533-1644
	Email:
Address: 11 Awl St, Medway	
Owner(s): Justin & Jennifer Smith	Phone: 239-560-2322
	Email: justin@sunwestsales.com
Mailing Address: 18 Broad Acres, Medway, MA 02053	

Please list name and address of other parties with financial interest in this property (use attachment if necessary):

Please disclose any relationship, past or present, interested parties may have with members of the ZBA:

I hereby certify that the information on this application and plans submitted herewith are correct, and that the application complies with all applicable provisions of Statutes, Regulations, and Bylaws to the best of my knowledge, and that all testimony to be given by me during the Zoning Board of Appeals public hearing associated with this application are true to the best of my knowledge and belief.

[signature] 05/06/20

Signature of Applicant/Petitioner or Representative *Date*

Signature Property Owner (if different than Applicant/Petitioner) *Date*

Received by: Date:

APPLICATION INFORMATION

		YES	NO
Applicable Section(s) of the Zoning Bylaw:	Requesting Waivers?	☐	☑
8.2 Accessory Family Dwelling Unit	Does the proposed use conform to the current Zoning Bylaw?	☑	☐
Present Use of Property: Residential	Has the applicant applied for and/or been refused a building permit?	☐	☑
	Is the property or are the buildings/ structures pre-existing nonconforming?	☐	☑
Proposed Use of Property: Same with accessory family dwelling	Is the proposal subject to approval by the BOH or BOS?	☐	☑
	Is the proposal subject to approval by the Conservation Commission?	☐	☑
Date Lot was created: 1999	Is the property located in the Floodplain District?	☐	☑
Date Building was erected: 2000	Is the property located in the Groundwater Protection District?	☐	☑
Does the property meet the intent of the Design Review Guidelines? Yes	Is the property located in a designated Historic District or is it designated as a Historic Landmark?	☐	☑

Describe Application Request:
To erect an accessory dwelling for an in-law unit.

Received by: Date:

FILL IN THE APPLICABLE DATA BELOW

Required Data	Bylaw Requirement	Existing	Proposed
A. Use		Single family	A.F.D.U.
B. Dwelling Units	1	1	2
C. Lot Size	44000	44010	44010
D. Lot Frontage	180'	180'	180'
E. Front Setback	35'		112'
F. Side Setback	15'		35'
G. Side Setback	15'		
H. Rear Setback	15'		63'
I. Lot Coverage	25%		
J. Height	35'		~25'
K. Parking Spaces	Exempt under 3.5	4	6
L. Other			

FOR TOWN HALL USE ONLY

To be filled out by the Building Commissioner:

Date Reviewed

Medway Building Commissioner

Comments:

After completing this form, please submit an electronic copy to zoning@townofmedway.org and 4 paper copies to the Community & Economic Development Department.

Received by: Date:

TOWN OF MEDWAY

ZONING BOARD OF APPEALS

155 Village Street
Medway MA 02053

Phone: 508-321-4915 | zoning@townofmedway.org
www.townofmedway.org/zoning-board-appeal

NOTE: THE APPLICATION WILL NOT BE CONSIDERED "COMPLETE" UNLESS ALL NECESSARY DOCUMENTS, FEES, & WAIVER REQUESTS ARE SUBMITTED. A GENERAL APPLICATION FORM MUST BE COMPLETED FOR ALL APPLICATIONS.

TO BE COMPLETED BY THE APPLICANT

Please provide evidence regarding how the Special Permit Decision Criteria, outlined below, is met. Please write "N/A" if you believe any of the Criteria is Not Applicable. Provide attachments if necessary.

1. **The proposed site is an appropriate location for the proposed use:**

There is ample area and setbacks for the proposed dwelling, there is provision for it in the zoning bylaw and there is no visible wetland.

2. **Adequate and appropriate facilities will be provided for the operation of the proposed use:**

All the utilities will be connected to the main dwelling unit utilities.

3. **The proposed use as developed will not create a hazard to abutters, vehicles, pedestrians, or the environment:**

The zoning bylaws will be adhered to with regard to setback and height restrictions.

4. **The proposed use will not cause undue traffic congestion or conflicts in the immediate area:**

No impact to neighborhood, the design is consistent with current single family dwelling.

5. **The proposed use will not be detrimental to the adjoining properties due to lighting, flooding, odors, dust, noise, vibration, refuse materials, or other undesirable visual, site, or operational attributes of the proposed use:**

The design and use is in keeping with the nature of the surrounding area and zoning bylawys.

6. **The proposed use as developed will not adversely affect the surrounding neighborhood or significantly alter the character of the zoning district:**

The design and use is in keeping with the nature of the surrounding area and zoning bylawys.

Received by: ______________________ Date: __________

7. **The proposed use is in harmony with the general purpose and intent of this Zoning Bylaw:**

Yes, continued residential use as an in-law.

8. **The proposed use is consistent with the goals of the Medway Master Plan:**

N/A

9. **The proposed use will not be detrimental to the public good:**

N/A

Signature of Applicant/Petitioner or Representative

05/06/20

Date

Received by: ______ Date: ______

TREASURER/COLLECTOR CERTIFICATION

TOWN OF MEDWAY

ZONING BOARD OF APPEALS

155 Village Street
Medway MA 02053

Phone: 508-321-4915 | zoning@townofmedway.org
www.townofmedway.org/zoning-board-appeal

TO BE COMPLETED BY THE APPLICANT

Applicant/Petitioner(s):

Justin & Jennifer Smith

Property Owner(s):

Justin & Jennifer Smith

Site Address(es):

18 Broad Acres, Medway MA 02053

Parcel ID(s):

19-003

Registry of Deeds Book & Page No. and Date or Land Court Certificate No. and Date of Current Title:

Book 32681 pg 556 (Plan No 829 of 1999 in Plan Bk 471)

Justin Smith

Justin Smith

Digitally signed by Justin Smith
Date: 2020.04.27 11:20:06 -04'00'

Signature of Applicant/Petitioner or Representative *Date*

FOR TOWN HALL USE ONLY

To be filled out by the Treasurer/Collector:

Date Reviewed ______________ Medway Treasurer/Collector ______________

Tax Delinquent: **Y** **N**

Comments:

Reviewed by: ______________ Date: ______________

TOWN OF MEDWAY
COMMONWEALTH OF MASSACHUSETTS

ZONING BOARD OF APPEALS

Medway Town Hall
155 Village Street
Medway, MA 02053
Phone (508) 321-4890
Email: zoning@townofmedway.org
www.townofmedway.org

Representative Authorization Form

I, Justin & Jennifer Smith certify that I am the owner of the property and I am aware of and authorize the submission of this application being submitted by my representative Todd Allen.

All information submitted is accurate to my knowledge.

Justin & Jennifer Smith	18 Broad Acres Farm Rd, Medway
Property Owner Name	Property Address
239-560-2322	19-003
Telephone Number	Parcel ID
justin@sunwestsales.com	AR--I
Email Address	Zoning District

Justin Smith
Property Owner Signature

05/06/20
Date

Please Note: *This form must be returned to the Zoning Board of Appeals when submitting the application if being completed by a representative or it will be incomplete until this form is completed.*

TOWN OF MEDWAY
BOARD OF ASSESSORS
155 VILLAGE STREET
MEDWAY, MA 02053
PHONE: 508-533-3203 FAX: 508-321-4981
www.townofmedway.org

REQUEST FOR ABUTTERS

Date of Request: May 1, 2020

Property owner: Justin & Jennifer Smith

Property location: 18 Broad Acres Farm Road, Medway

Parcel (property) ID(S): 19-003

Please specify: 100', 300' or 500' from subject parcel: 300'

THIS LIST IS REQUESTED FOR:

- [ ] Planning & Economic Development Board
- [x] Zoning Board of Appeals
- [ ] Conservation Commission
- [ ] Historical Commission

REQUESTER INFORMATION:

Name: Justin & Jennifer Smith

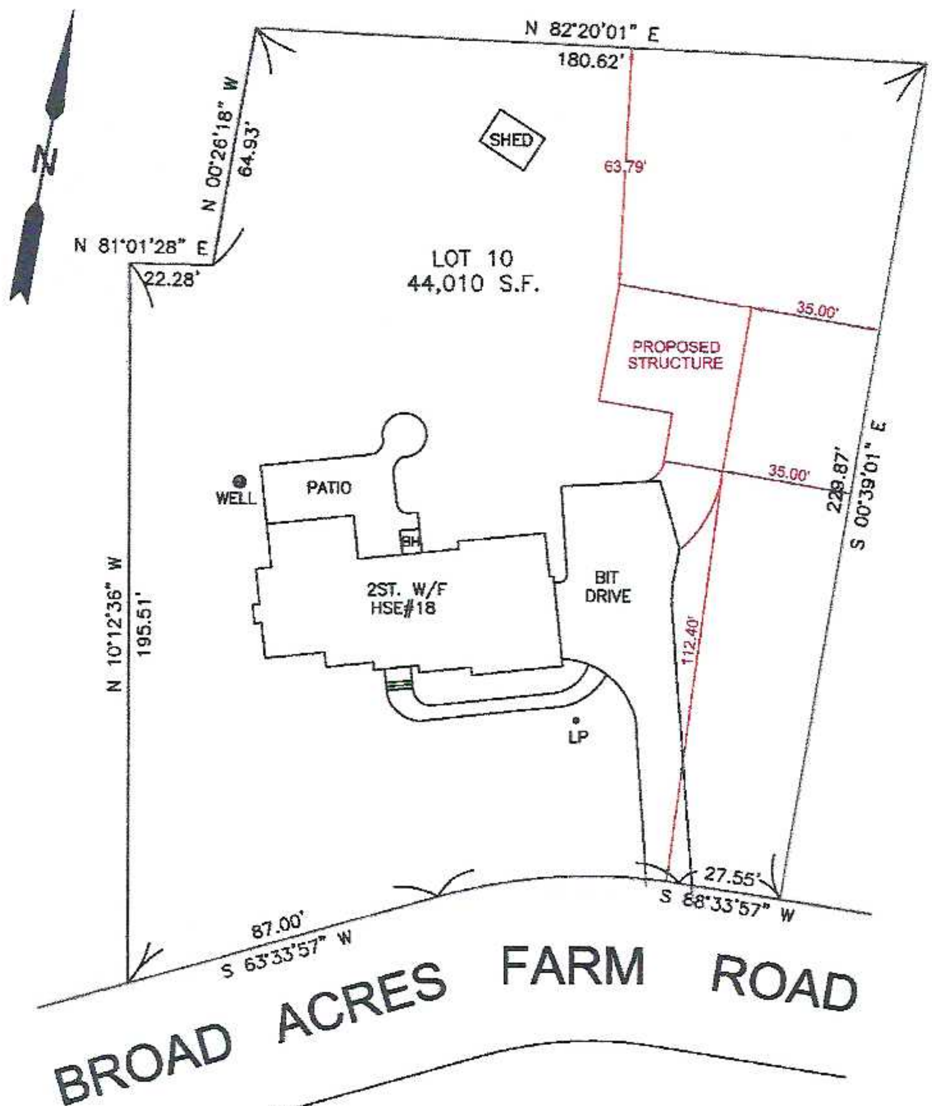
Email address: justin@sunwestsales.com

Address: 18 Broad Acres Farm Rd
Medway, MA 02053

Please Return to MEDWAY ZBA
Community and Economic Development Department

Phone: 239-560-2322

THERE IS A FEE OF $15.00 PER PARCEL DUE AT THE TIME OF REQUEST. THE LIST IS VALID FOR 90 DATE OF CERTIFICATION DATE. THE BOARD OF ASSESSORS RESERVES 10 WORKING DAYS TO PROVIDE ALL CERTIFIED LISTS OF ABUTTERS. ***IF YOU WISH TO HAVE THE LISTS MAILED BACK TO YOU, YOU MUST PROVIDE A SELF ADDRESSED STAMPED ENVELOPE LARGE ENOUGH FOR THREE SETS OF LABELS.***



ZONE AR I
AREA 44,000 S.F.
FRONTAGE 180'
SETBACK 35'
SIDEYARD 15'
REAYARD 15'
LOT COVERAGE
STRUCTURE 25%
STRUC. & IMPER. 35%

EXISTING LOT COVERAGE
STRUCTURE 6.63%
STRUC. & IMPER. 15.70%

PROPOSED LOT COVERAGE
STRUCTURE 9.71%
STRUC. & IMPER. 19.72%

I CERTIFY THAT THE PROPOSED STRUCTURE SHOWN ON THIS PLAN CONFORMS TO THE ZONING BY-LAWS OF THE TOWN OF MEDWAY, MA. AND DOES NOT LIE WITHIN THE FLOOD PLAIN.

COMMONWEALTH OF MASSACHUSETTS
PAUL J. DeSIMONE
No. 30466
PROFESSIONAL LAND SURVEYOR

PROPOSED STRUCTURE
PLAN OF LAND

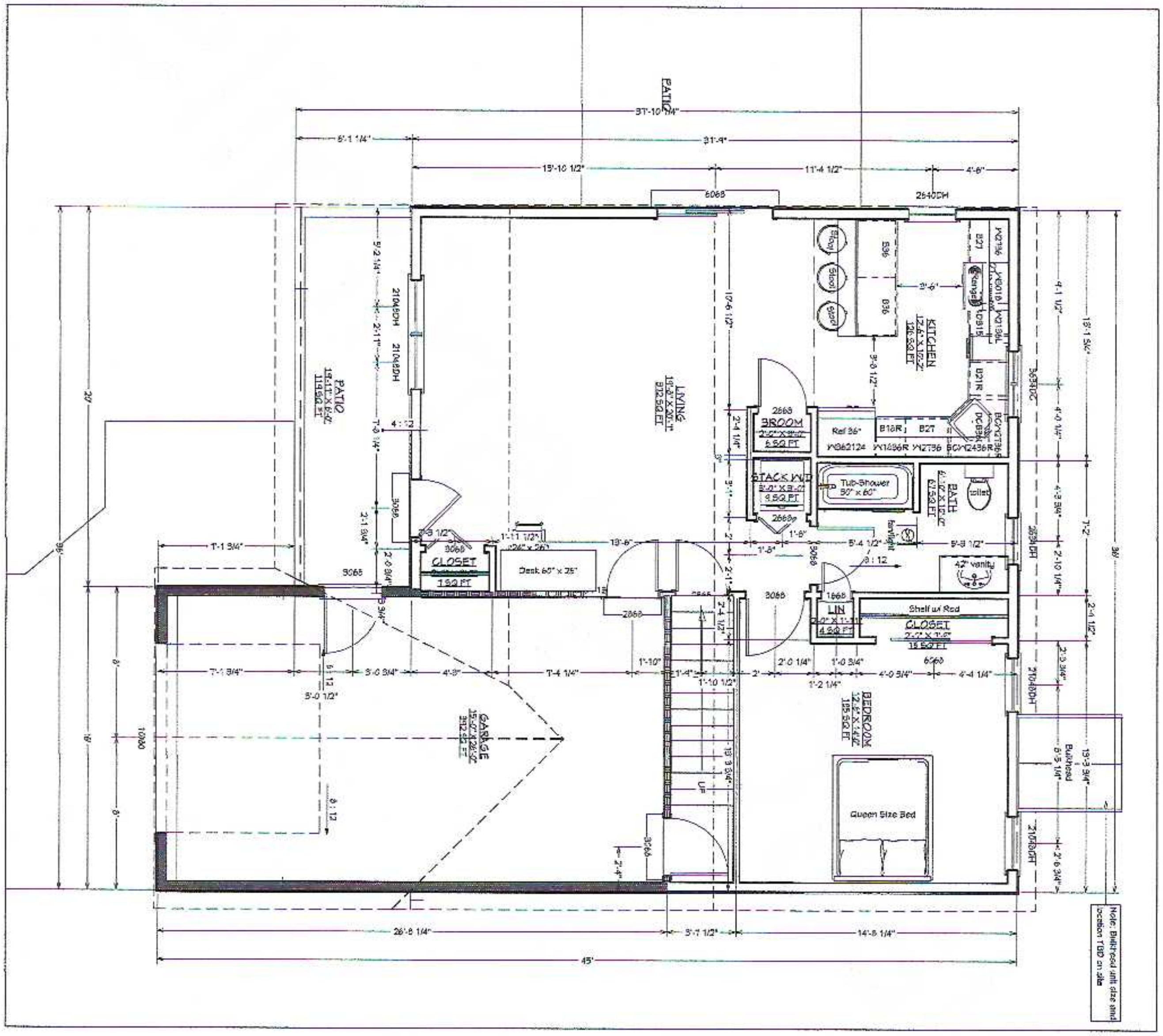
IN

MEDWAY, MA.

SCALE:1"=40' APRIL 23, 2020

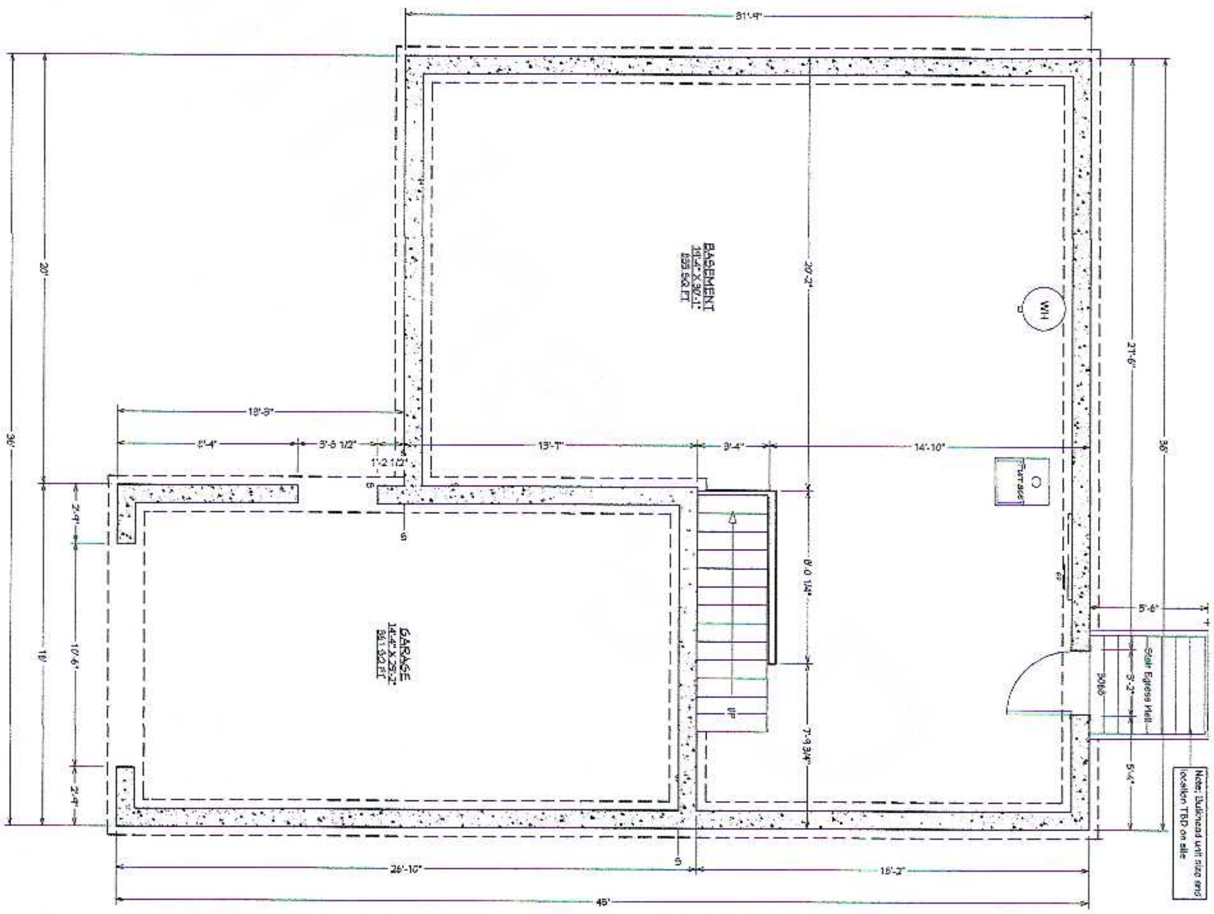
OWNER: Justin & Jennifer Smith
18 Broad Acres Farm Road
Medway, Ma. 02053

COLONIAL ENGINEERING INC.
11 AWL STREET MEDWAY, MA.
508-533-1644



SHEET:	SCALE:	DATE:				
2/	1/4" = 1'-0"	2/13/2020	Con n ...0269	Free Standing In-law 18 Broad Acres Farm Rd Medway, MA	1st Floor Plan 'Revision 1'	

NO.	DESCRIPTION	BY	DATE



SHEET: 1/

SCALE: 1/4" = 1'-0"

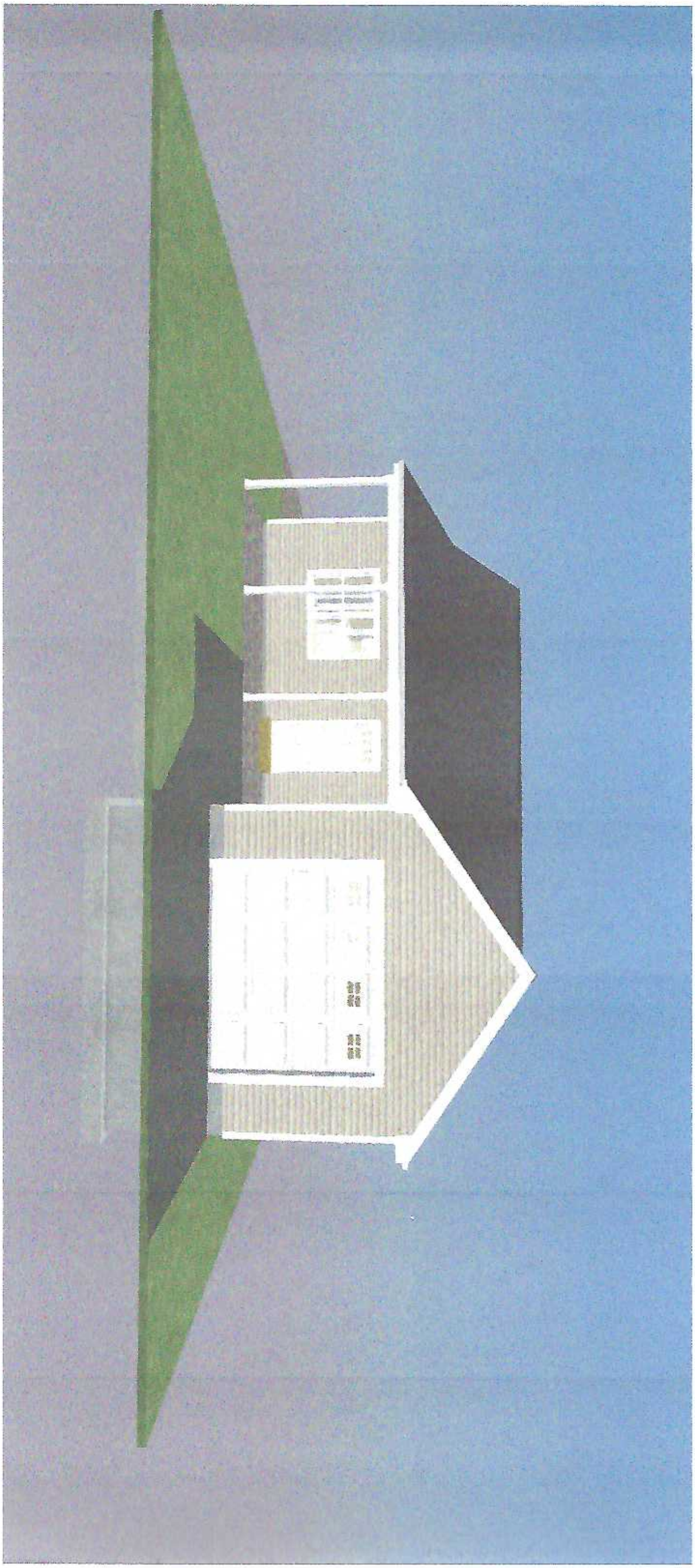
DATE: 2/13/2020

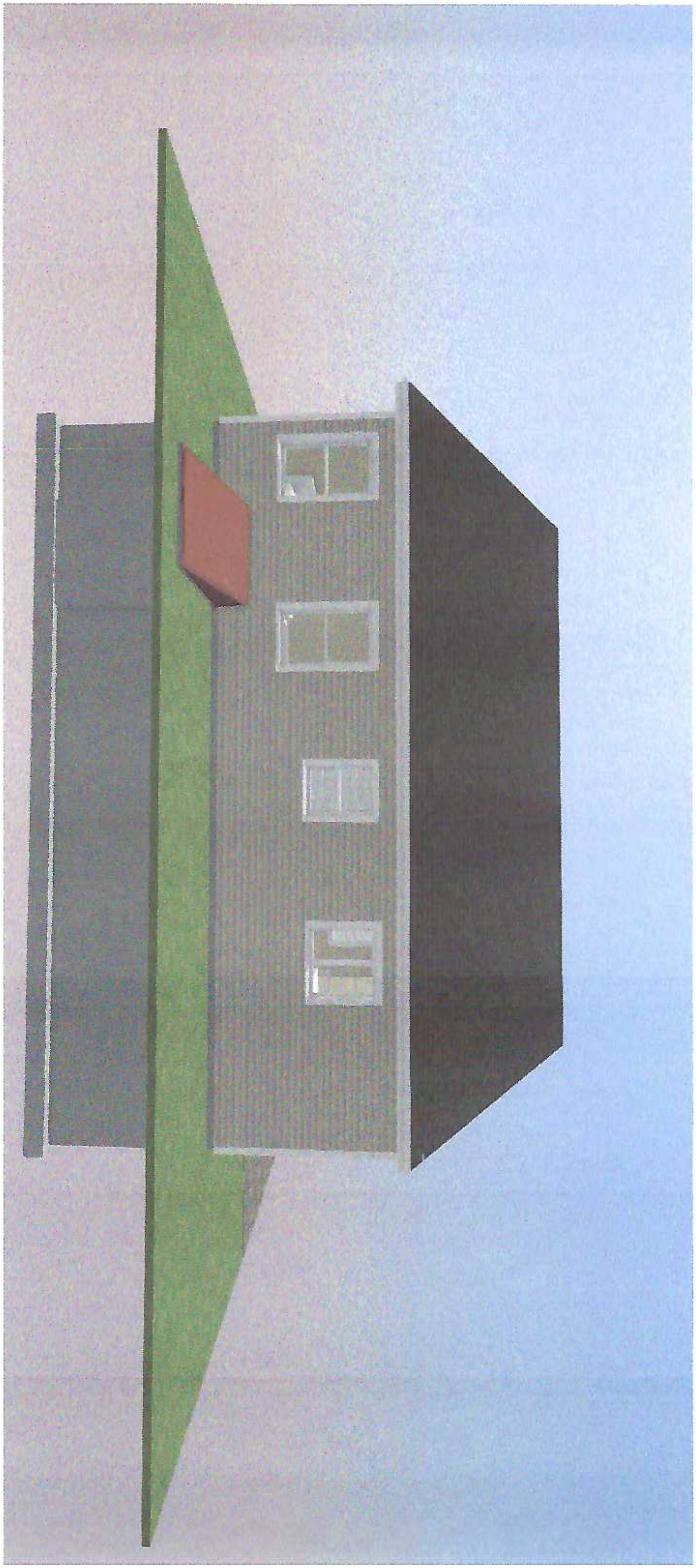
DRAWN FOR:
HIS Corporation
Medway, MA
508-533-6269

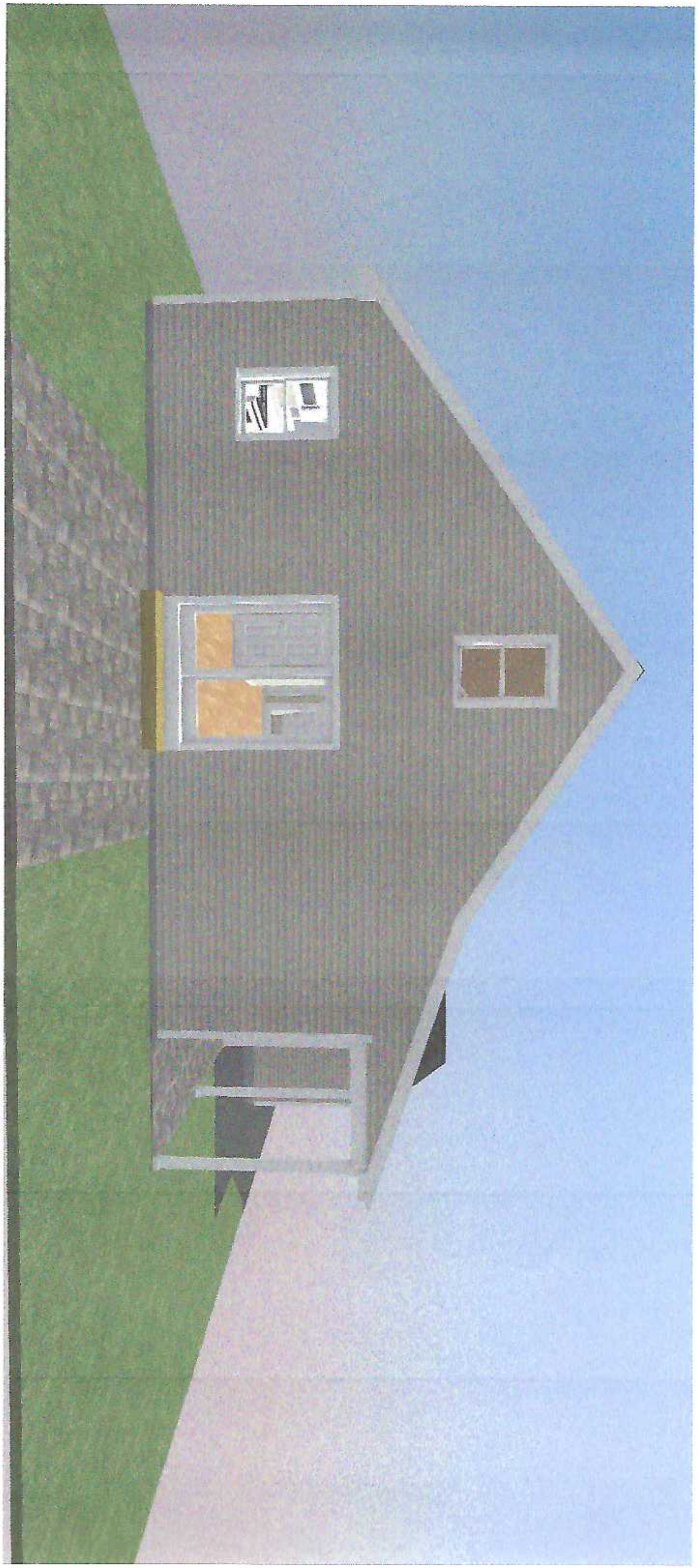
Free Standing In-law
18 Broad Acres Farm Rd
Medway, MA

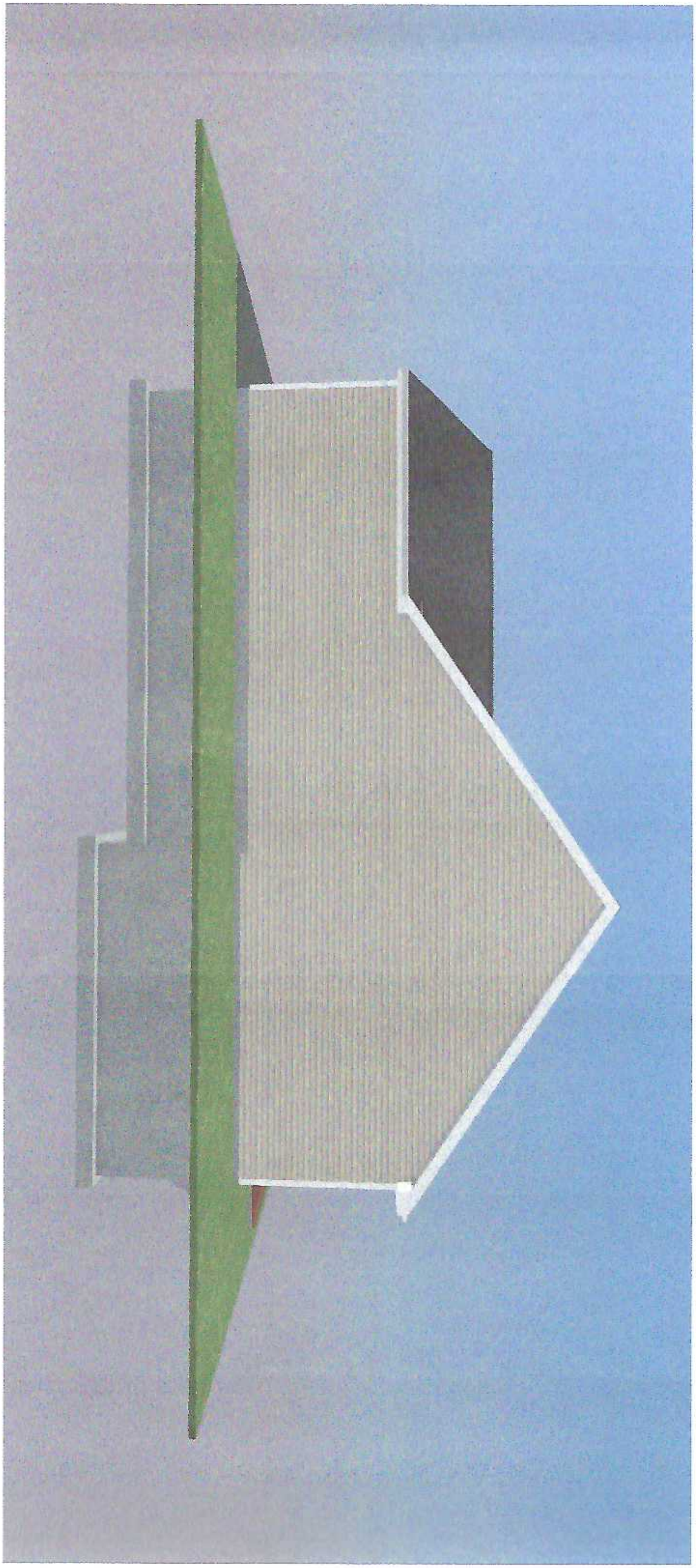
Foundation Plan
'Revision 1'

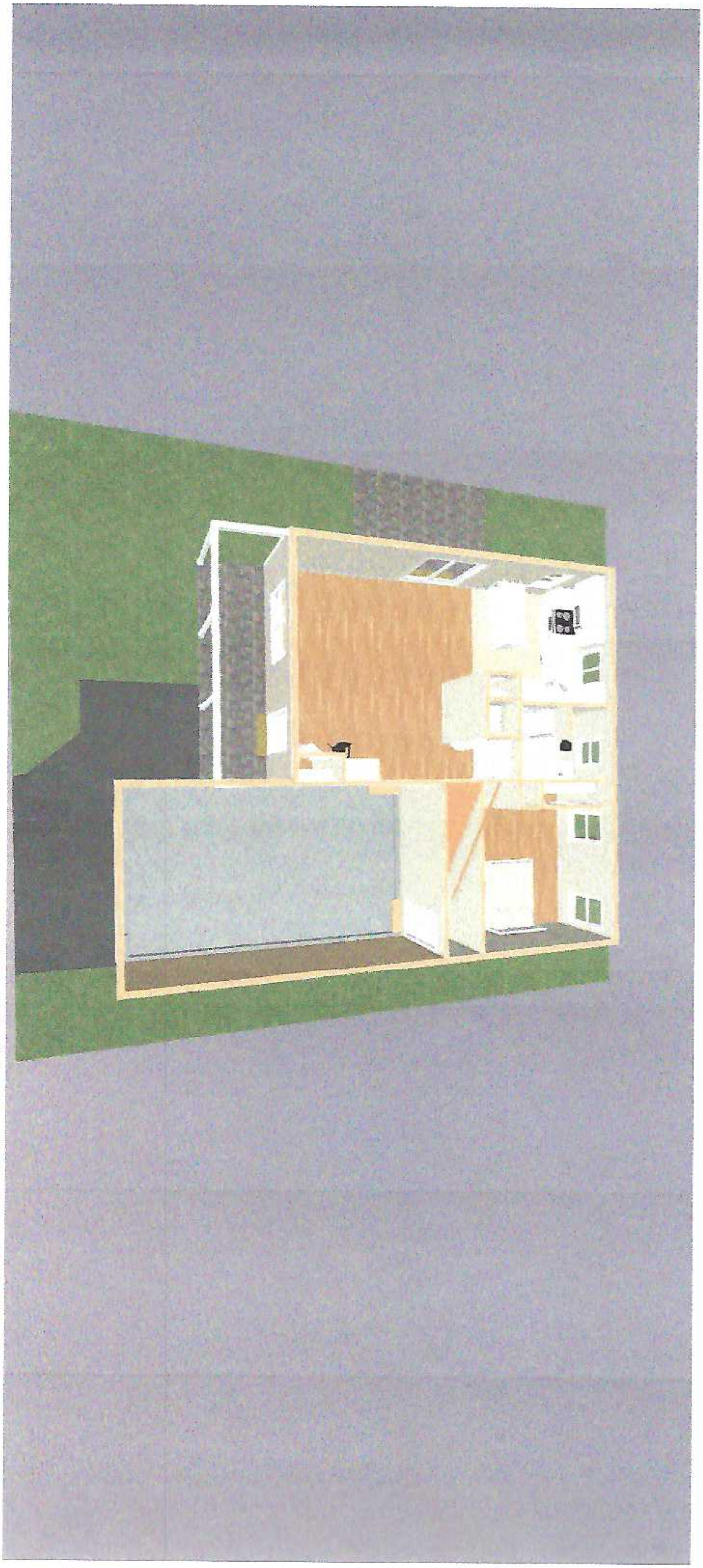
NO.	DESCRIPTION	BY	DATE

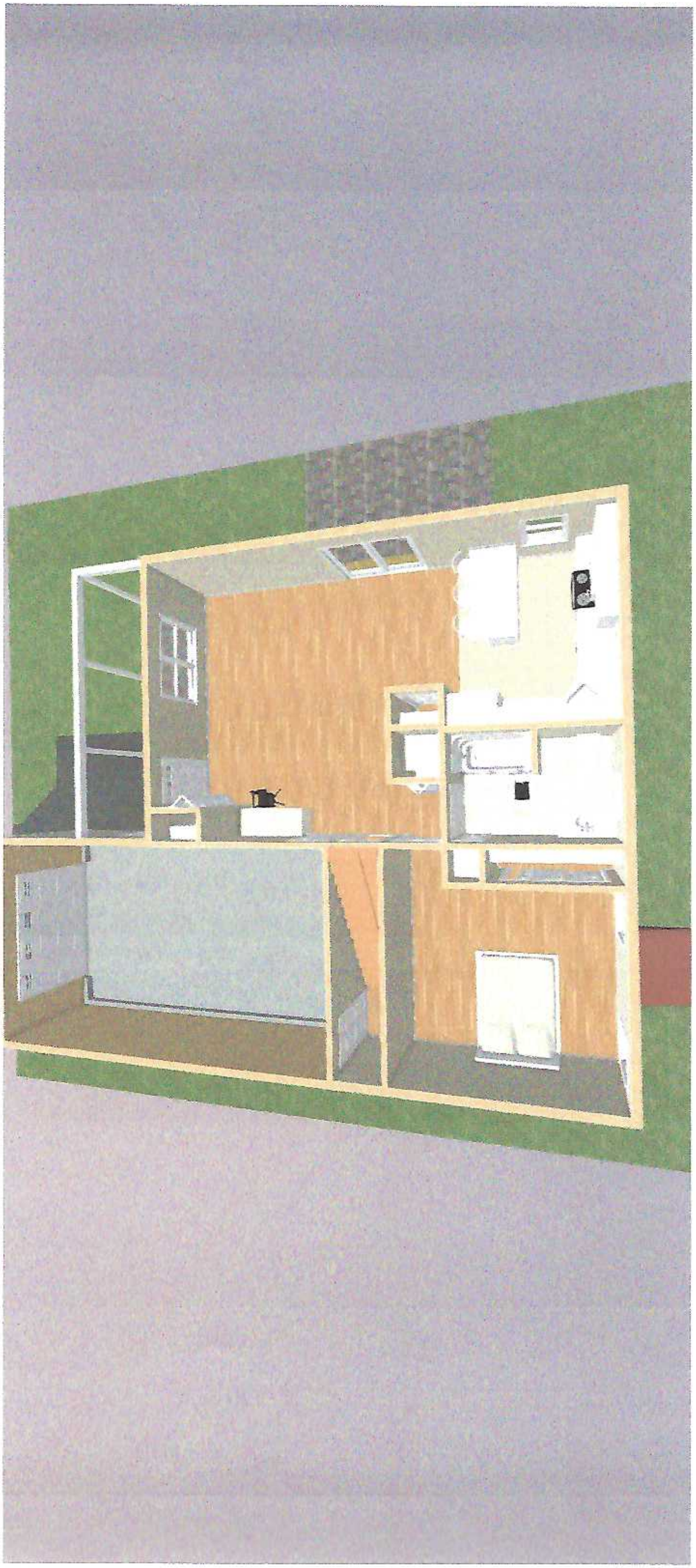


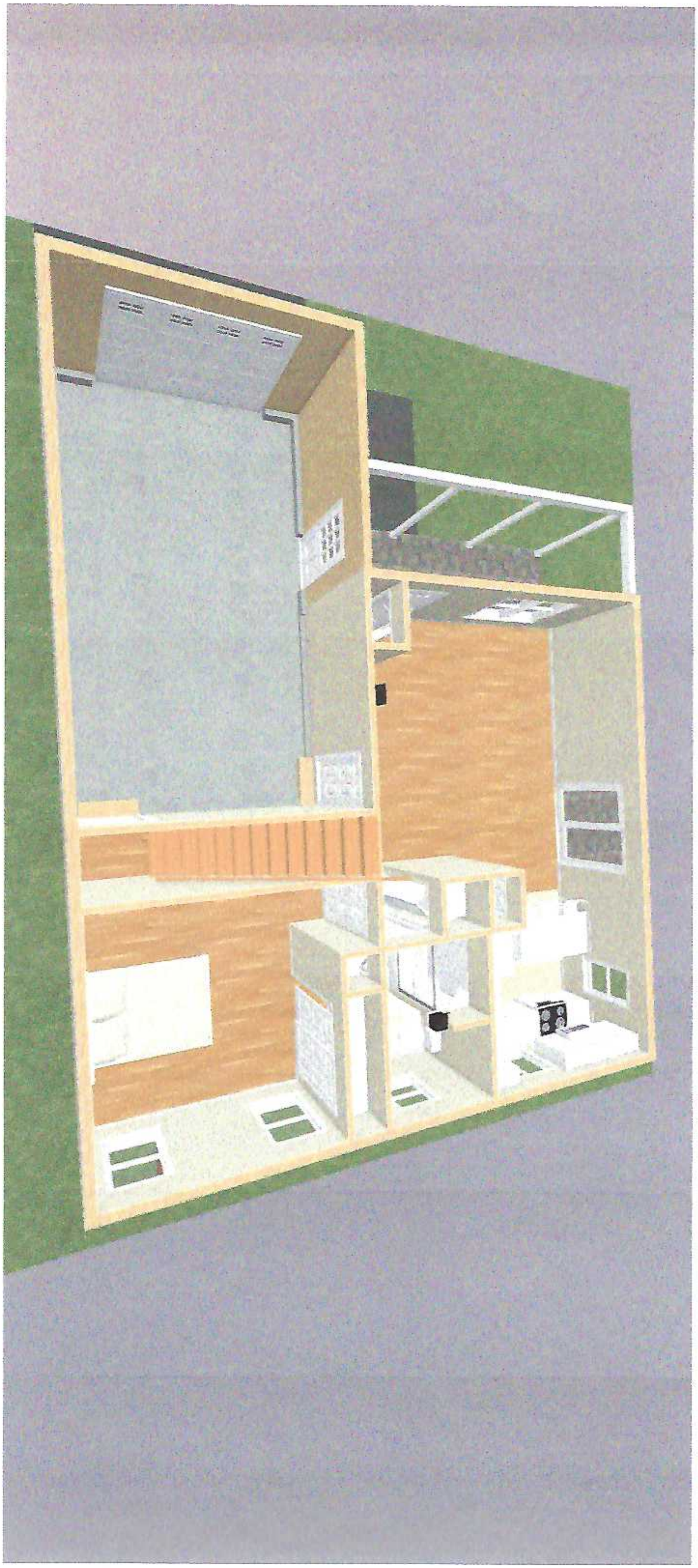












May 12, 2020

Medway Planning & Economic Development Board Meeting

PEDB Meeting Minutes

- Draft minutes of the April 28, 2020 PEDB meeting
- DRAFT corrected minutes of the March 5, 2020 PEDB meeting

Thursday March 5, 2020
Medway Planning and Economic Development Board
155 Village Street
Medway, MA 02053

Members	**Andy Rodenhiser**	**Bob Tucker**	**Tom Gay**	**Matt Hayes**	**Rich Di Iulio**	**Jessica Chabot**
Attendance	**X**	**Absent with Notice**	**X**	**Absent with Notice**	**X**	**X**

The meeting is being recorded by Medway Cable Access for rebroadcast.

ALSO PRESENT:

Susy Affleck-Childs, Planning and Economic Development Coordinator

The Chairman opened the meeting at 7:00 pm.

There were no Citizen Comments.

ZBA PETITION – Accessory Family Dwelling Unit (AFDU) Special Permit Application: 1 Applegate Road

The Board is in receipt of the following: (**See Attached**)

- AFDU special permit application materials. ZBA hearing date is March 18, 2020.

The Board reviewed the AFDU special permit application for 1 Applegate Road. Upon review, the Board does not have a problem with the project but will not provide any comments on the petition.

CONSTRUCTION OBSERVATION ESTIMATE:

The Board is in receipt of the following (**See Attached**)

- Construction Observation Estimate dated January 2, 2020 from Tetra Tech for 20 Broad Street for $9,111.00

On a motion made by Rich Di Iulio and seconded by Tom Gay, the Board voted unanimously to approve the construction observation estimate for 20 Broad Street as presented.

PLAN ENDORSEMENT – 4 Marc Road Site Plan (NeoOrganics)

The Board is in receipt of the following (**See Attached**)

- Site plan dated August 6, 2019, last revised December 13, 2019 by DGT Associates Surveying and Engineering
- Special permit and site plan decision voted January 28, 2020 and filed with the Town Clerk on January 30, 2020.

Susy Affleck-Childs reported that all was in order. She received the Certificate of No Appeal today from the Town Clerk and the taxes are current on the property. She recommends endorsement.

On a motion made by Rich Di Iulio and seconded by Tom Gay, the Board voted unanimously to approve plan endorsement for 4 Marc Road as presented.

NOTE - The Board will sign the plan at the conclusion of the meeting.

PEDB MINUTES:

February 25, 2020:

On a motion made by Rich Di Iulio and seconded by Tom Gay, the Board voted unanimously to approve the minutes from the February 25, 2020 PEDB meeting.

March 2, 2020:

On a motion made by Rich Di Iulio and seconded by Tom Gay, the Board voted unanimously to approve the minutes from the March 2, 2020 PEDB meeting.

CORRESPONDENCE:

The Board is in receipt of the following (**See Attached**)

- March 4, 2020 PEDB memo to ZBA re: 119A and 119 B and Elm Street petitions (Site formerly known as 123 Main Street)

MARZILLI (21 TROTTER DRIVE) SITE PLAN ENDORSEMENT:

Susy Affleck-Childs reported that the plan needed to be revised and now re-endorsed due to the Registry of Deeds plan requirements.

On a motion made by Rich Di Iulio and seconded by Tom Gay, the Board voted unanimously to re-endorse the Marzilli Site Plan as presented.

NOTE – The plan will be signed at the conclusion of the meeting

REPORTS:

- The Board was informed that the public hearing on the Medway Mill Site Plan will begin March 24, 2020.
- Chairman Rodenhiser informed the members that he had attended the ZBA meeting regarding the petition of the owner of 119 A & B Main Street and 1-3 Elm Street to modify the previously issued variance. They wanted to have the driveway come in off of Main Street. He presented the position of the PEDB. The ZBA made a decision to deny the petition. The applicant chose to withdraw the application.
- The next SWAP meeting is scheduled for March 17, 2020. The topic is master planning.

EVERGREEN VILLAGE PUBLIC HEARING CONTINUATION

The Board is in receipt of the following: (**See Attached**)

- Public Hearing Continuation Notice

- Revised Site Plan dated 2-11-2020 by project engineer Ron Tiberi
- Letter dated 2-27-20 from project engineer Ron Tiberi in response to the 12-10-19 Tetra Tech review letter.
- 3-3-20 review letter from Tetra Tech on the revised site plan
- 3-3-20 email note from Gino Carlucci on the revised site plan.
- 2-27-20 email note Sergeant Jeff Watson recommending removal of 32" tree in the Evergreen Street right of way.

Ron Tiberi was present along with applicant Maria Varicchione. Mr. Tiberi explained the most recent update plan. The Conservation Commission is in the process of drafting an Order of Conditions. The Commission has added more greenery. There will also be a sign regarding no snow storage near the wetland areas. It was suggested that a condition be added that if there is too much snow, it will need to be moved off site. There have been no changes to the building footprints. There was an email dated 2-27-20 from Sergeant Watson recommending the removal of 32" tree located in the ROW near the northwest side of the lot to enhance the sight line pulling out of the development. The applicant will need to contribute to the tree fund for the value of the tree removal. Susy Affleck-Childs will prepare the tree replacement value calculations and provide to the applicant. The Board suggested that the applicant contact Sergeant Watson again about saving the 32' tree and consider pruning. A question was asked about mail delivery. The applicant will reach out to the postmaster about mail delivery. The Board would like the applicant to get some form of communication from the postmaster and have this detail added to the plan. Perhaps a small but attractive shed could be used to house the multi-unit mail box.

On a motion made by Rich Di Iulio and seconded by Tom Gay, the Board voted unanimously to continue the hearing for Evergreen Village to March 18, 2020 at 7:45 pm in the Town Administrators Conference Room.

<u>MEDWAY PLACE SHOPPING PLAZA SITE PLAN – Public Hearing Continuation</u>

The Board is in receipt of the following: (**See Attached**)

- Continuation Request dated March 3, 2020 from attorney Gareth Orsmond requesting a continuation to the March 24, 2020 meeting.

On a motion made by Rich Di Iulio and seconded by Tom Gay, the Board voted unanimously to continue the hearing for Medway Place Shopping Plaza Site Plan to March 24, 2020 at 9:00 pm.

<u>HILLSIDE VIEW ESTATES SUBDIVISION:</u>

The Board was informed that the bond for this project, as discussed at the last meeting, has not expired. The bond company issued two riders to the policy to address the Board's concerns. Dan Merrikin has not yet provided a letter relating to the drainage. A question was asked if the other abutter will be aware that their access will be impeded when the road and drainage work is to be completed. There will be a preconstruction meeting with applicant. It was suggested to have a document written up such as a contract to insure maintaining access for the neighbor and make an addendum to the Certificate of Action to outline those procedures. There was no action taken by the Board.

ZONING BYLAW - ENVIRONMENTAL STANDARDS:

The Board is in receipt of the following: (**See Attached**)

- February 28, 2020 email from John Lally summarizing his concerns about the proposed new odor standards.
- Email from noise consultant Jeff Komrower of Noise Control Engineering, dated March 4, 2020.
- Letter from odor consultant Bruce Straughan of Straughan Forensic, LLC, dated March 4, 2020

The Board was informed that comments were received from noise consultant Jeff Komrower and odor consultant Bruce Straughan on the draft of the new environmental standards for the Zoning Bylaw. The consultants' comments have been forwarded to the Board's environmental zoning consultant Caroline Wells from Weston and Sampson. It was suggested to have a special meeting on Wednesday, March 18, 2020 to further discuss this information. The public hearing for this is scheduled for March 24, 2020.

Resident John Lally was present. Mr. Lally indicated that the email from noise consultant Jeff Komrower did note that lowering the acceptable noise level to between 42-45 dBA would be a reasonable option, but in his opinion, anything above that, i.e. 43dBA to 45dBA, is not reasonable, is inappropriate for Medway, and he could not support it at town meeting. He further noted that he continues to feel that the maximum night-time noise level should be set at 40dBA. He indicate he is cautious about using the environmental standards adopted for the state since those standards urban and rural areas. The town could end up with higher thresholds than what are appropriate for the Town of Medway. This is what happened with the 2 Marc Road project.

Mr. Lally next referenced the letter from odor consultant Bruce Straughan. Mr. Straughan's work experience was from the City of Denver. The Nasal Ranger olfactometer device is used in Denver as a tool in determining odor levels. Denver uses the 7:1 dilution threshold level. Mr. Lally commented that he could not disagree more with the idea of using the DT=7:1 odor criteria. The odor of marijuana using the Nasal Ranger would need to trigger 7 times to detect it at a violation level. You do not need a factor of 7 to make marijuana odor objectionable.

The Chairman noted that he is concerned that the town is a year too late in putting this in place. Another option is threshold which possibly could be based on complaints which would make it enforceable. The protocol for this needs to be discussed thoroughly. The testing of the odor would need to be at the output location. There would need to be language about the type of equipment and have the protocol with specifications. The Consultants will be invited to the next meeting on March 18, 2020.

Chairman Rodenhiser noted that he is concerned that the Town is a year too late in putting these provisions in place. Mr. Straughan suggested adding another measure. It would be a threshold based on a certain number of odor complaints which would make it enforceable. The protocol for this needs to be discussed thoroughly. The testing of the odor would need to be at the output location, not at the property line. There would need to be language about the type of equipment and have the protocol with specifications.

The odor and noise consultants will be invited to the next PEDB meeting on March 18, 2020 to assist in working this through.

MASTER PLAN DISCUSSION:

The Board was informed that Barbara Saint Andre is preparing an RFP for consultant work on the Master Plan. The Master Plan was last completed in 2009. The engagement portion of the RFP could be done by one firm and the data collection could be completed by another firm. This is being discussed. There will need to be input from a variety of Board and Committee members along with citizens at large. One of the community engagement approaches in other towns is holding a series of focus groups in neighborhoods. There will also be a variety of surveys which could be completed. The goal is to get data in a variety of ways. There was a suggestion to use the voter registration list. The scope of the master plan would include Health, Arts and Culture. There would also be the expansion of addressing climate change and sustainability with possible using not using fossil fuels as much. An example of this might be having a joint solar field instead of ones on individual homes, and gas stations with solar power. The format of working of the Master Plan will need to be discussed further at a later date.

FUTURE MEETING:

- Wednesday, March 18, 2020

ADJOURN:

On a motion made by Rich Di Iulio and seconded by Tom Gay, the Board voted unanimously to adjourn the meeting.

The meeting was adjourned at 8:50 pm.

Prepared by,
Amy Sutherland
Recording Secretary
From video recording

Reviewed and edited by,
Susan E. Affleck-Childs
Planning and Economic Development Coordinator

Tuesday April 28, 2020
Medway Planning and Economic Development Board
155 Village Street
Medway, MA 02053

Members	**Andy Rodenhiser**	**Bob Tucker**	**Tom Gay**	**Matt Hayes**	**Rich Di Iulio**	**Jessica Chabot**
Attendance	**X**	**X**	**X**	**X**	**X**	**X**

Pursuant to Governor Baker's March 12, 2020 Order Suspending Certain Provisions of the Open Meeting Law, and the Governor's March 15, 2020 Order imposing strict limitations on the number of people that may gather in one place, <u>no in-person attendance of members of the public will be permitted</u> <u>at this meeting.</u> Members of the public who wish to watch the meeting may do so, on Medway Cable Access: channel 11 on Comcast Cable, or channel 35 on Verizon Cable; or on Medway Cable's Facebook page @medwaycable.

ALSO PRESENT IN ZOOM MEETING:

- Susy Affleck-Childs, Planning and Economic Development Coordinator
- Amy Sutherland, Recording Secretary
- Barbara Saint Andre, Director of Community and Economic Development

The Chairman opened the meeting at 7:01 pm.

There were no Citizen Comments.

<u>Hill View Estates Subdivision (Nirvana Way)</u>

The Board is in receipt of the following: (**See Attached**)

- Updated Tetra Tech bond estimate dated April 15, 2020 for the roadway and drainage work.

The Board was informed that the buyer, Sean Smith, is in the process of securing suitable performance security. He is exploring options which include putting up assets and cash. There will most likely be a Tri-Partite Agreement. The amount of the Tetra Tech bond estimate is $128,173.00.

<u>Evergreen Village Construction Services</u>

The Board is in receipt of the following: (**See Attached**)

- Tetra Tech construction services estimate dated April 15, 2020 for $14,096.

On a motion made by Bob Tucker and seconded by Tom Gay, the Board voted by Roll Call to approve the construction services estimate for Evergreen Village as presented.

Roll Call Vote:

Rich Di Iulio	**aye**
Bob Tucker	**aye**
Tom Gay	**aye**
Andy Rodenhiser	**aye**
Matt Hayes	**aye**

PEDB METING MINUTES:

April 14, 2020:

On a motion made by Rich Di Iulio and seconded by Tom Gay, the Board voted by Roll Call to approve the minutes from the April 14, 2020 meeting with the requested amendments.

Roll Call Vote:

Rich Di Iulio	**aye**
Bob Tucker	**aye**
Tom Gay	**aye**
Andy Rodenhiser	**aye**
Matt Hayes	**aye**

Other Business:

The Board was informed that Governor Baker has extended the State of Emergency to May 18, 2020. The Board needs to decide how they want to handle the hearings to be held on May 12, 2020. Barbara Saint Andre communicated that there has been information from the Supreme Judicial Court which indicated that the courts will be closed until June 1, 2020. This is relevant since the statutes of limitations for appeals will not start until June 1, 2020.

The Chairman declared the continuation of the public hearings of Medway Mills and Medway Place originally scheduled for May 12, 2020 to take place on May 26, 2020.

On a motion made by Tom Gay and seconded by Rich Di Iulio, the Board voted by Roll Call to ratify and affirm the declaration of the Chairman to continue the site plan hearings for Medway Mills and Medway Place to May 26, 2020.

Roll Call Vote:

Rich Di Iulio	**aye**
Bob Tucker	**aye**
Tom Gay	**aye**
Andy Rodenhiser	**aye**
Matt Hayes	**aye**

On-Call Engineering Services:

The Board was informed that there were seven proposals received for Peer Review engineering services for Town Boards and Departments. There was a team who reviewed the proposals based on a set criterion. It was decided to continue with Tetra Tech. The recommendation for Tetra Tech services will be presented to the Board of Selectmen on May 18, 2020 for contract approval.

Forest Road – Hidden Pines Subdivision:

The Board is in receipt of the following: (**See Attached**)

- Mutual Release of Claims
- Letter dated 4-21-20 sent to Paul and John Rivard as owners of Forest Road.
- Email dated 4-23-20 from Attorney Cannon on behalf of the Rivards.

Attorney Ted Cannon was present during the Zoom Meeting as representative of Paul and John Rivard. He communicated that the Rivards are willing to convey the road to the Town in return for a release from the Town from any further responsibility for the road. The Board was informed that the Board of Selectmen voted at their 4-21-20 meeting to "lay out" Forest Road per the Planning and Economic Development Board's recommendation. Town Counsel was asked to prepare the mutual release document to be executed by the BOS and the Rivards. The amount of the remaining performance security is $6,425.00. This will go to the BOS for its May 4, 2020 meeting.

On a motion made by Matt Hayes, and seconded by Rich Di Iulio, the Board voted by Roll Call vote to recommend that the Medway Board of Selectmen approve and sign the Mutual Release of Claims between the Town of Medway and Paul and John Rivard pertaining to the release of performance security for the Hidden Pines subdivision and the conveyance of Forest Road to the Town of Medway.

Roll Call Vote:

Rich Di Iulio	**aye**
Bob Tucker	**aye**
Tom Gay	**aye**
Andy Rodenhiser	**aye**
Matt Hayes	**aye**

Attorney Cannon will coordinate the signing of the documents by the Rivards.

MILLSTONE VILLAGE – Request for Final Occupancy Permit

The Board is in receipt of the following: (**See Attached**)

- 4-22-20 Annotated Punch List from Millstone developer Steve Venincasa with comments on status of punch list items.
- Collection of emails between Susy Affleck-Childs and Steve Venincasa from 4-15-20 through 4-22-20.

Present during the Zoom call:

- Millstone Site Superintendent Brian Clark
- Barbara Venincasa.
- Janet Pegoraro - Buyer of final Millstone property.

Brian Clark explained the progress to date on the punch list items:

- Top course on Steppingstone Drive – Being completed.
- Landscaping in center island – Landscapers on site completing task.
- Installation of trail – Landscapers on site completing task.
- Overflow devices on all roof leaders – On order, have not been shipped.

- Grading and loaming – being completed.
- Stabilized exposed soils under decks and around foundation – Currently completing.

Board members noted that there has been significant work done on completion of the punch list.

On a motion made by Matt Hayes and seconded by Rich Di Iulio, the Board voted by roll call vote to authorize the Building Commissioner issue the final occupancy permit at Millstone Village.

Roll Call Vote:

Rich Di Iulio	**aye**
Bob Tucker	**aye**
Tom Gay	**aye**
Andy Rodenhiser	**nay**
Matt Hayes	**aye**

Susy Affleck-Childs will communicate the decision of the Board to the Building Commissioner.

EVERSOURCE SITE PLAN – Field Change Discussion

The Board is in receipt of the following: (**See Attached**)

- Proposed Revised Landscaping Plan Station 65 to 34 West Street)

Member Gay recused himself from the conversation.

The following were present during the ZOOM meeting:

- Eversource personnel Jared Blandino, Leah Gymziak, Duane Boyce, Julio Franco, Michael Babineau, Karen Schlomy and Matthew Waldrip
- Beals and Thomas landscape architect Regan Harold

The Board was made aware that a site plan decision for the Eversource site was endorsed in May 2016. Eversource has completed the work shown on the site plan except for the landscaping. Since 2016, Eversource has changes its standards/criteria for landscaping. The applicant has prepared a revised plan dated 4-8-20. A PowerPoint presentation was provided. (**See Attached**) The Eversource Transmission Vegetation Management standards have been modified for landscaping within the electric transmission right-of-way. The program looks to establish native shrubland-grassland comprised of low-growing compatible species. The low-growing species will not exceed 3' in mature height. In certain situations, compatible vegetation that does not exceed 15' at mature height may be allowed. No surrounding residences have direct sightlines to the portion of the site being landscaped. The vegetative screening will primarily be a benefit to drivers traveling along West Street. The proposed 2020 landscaping plan shows an increase in the number of plants from 47 to 162. The planting is intended to become a more naturalized shrub border, like the character of the existing landscape in the area.

The schedule for landscape installation was reviewed. A truck will be delivering water to the site. There was a concern about height of the plants along with the closeness of the plants to the edge of West Street. Regan Harold, landscape architect from Beals and Thomas responded that the lowest height plants were recommended closest to the street. She further explained that there could be field adjustments when this is laid out on site. The installation will be done by Weston Nurseries. It was also explained that the chosen plants will not need pruning. The Board was informed that the plan had been reviewed by Conservation Agent Bridget Graziano and she had recommended changes in some of the plant species to comply with the Order of Conditions. The planting scheme was revised to be fully native species. There was an elimination of the cultivator plants. The Board is fine with what was presented.

On a motion made by Bob Tucker, and seconded by Matt Hayes, the Board voted by Roll Call to approve the field change to approve the revised landscaping plan dated April 28, 2020 for Eversource at 34 West Street.

Roll Call Vote:

Rich Di Iulio	**aye**
Bob Tucker	**aye**
Tom Gay	**abstain**
Andy Rodenhiser	**aye**
Matt Hayes	**aye**

Member Gay returned to the meeting at 8:15 pm.

Zoning Bylaw – Environmental Standards:

The Board is in receipt of the following: (**See Attached**)

- Minutes of March 5, 2020 PEDB meeting
- Proposed draft revisions dated 2-12-20 with comments from noise consultant Jeff Komrower.
- 2-28-20 email from abutter John Lally summarizing his concerns about the proposed new odor standards.
- 3-4-20 email from Jeff Komrower with a collection of attachments.
- 3-4-20 letter from odor consultant Bruce Straughan with attachments.

The following were present during the zoom meeting:

- Jeffrey Komrower, Noise Consultant
- Bruce Straughan, Odor Consultant
- John Lally, resident
- Caroline Wells, Environmental Zoning Consultant from Weston and Sampson.

The Board was made aware that the last time this topic was discussed was at the March 5, 2020 meeting. The original goal for working on this was to have a draft for the Spring Town Meeting. Due to the current circumstances with COVID-19, all zoning articles have been removed from the Town Meeting warrant. The recommendation is to have this document ready for the Fall Town Meeting in November.

Consultant Wells from Weston and Sampson provided all members the clean draft copy of the Environmental Standards with the suggested comments and edits. After these were incorporated, Mr. Lally then had concerns and provided an email with a series of questions. The focus of the meeting was to be addressing these items.

NOISE STANDARDS

The first issue which needs to be resolved for the noise standards is to specify the octave bands either at 42 or 40 dB. The overall level currently is 47. The recommendation is for 42dB at nighttime, but Mr. Lally prefers 40 dB. Consultant Komrower responded that 2 dB's is not discernable in his professional opinion. The Town of Medway was 47 dB, so going down to 42 dB is a big jump downward and is closer to municipal standards around the country. Mr. Lally communicated that he expressed in his email that he prefers 40 but could support 42. Going above that he would have a hard time voting to support this at the town meeting. Consultant Komrower responded that traditionally you do not impose an overall level and have a full octave band level as a requirement. Consultant Komrower offered suggestions regarding the wording. Medway could require compliance only to the overall level unless verbiage was added to include "unless they do not meet the octave band levels". The Board needs to decide if they want to go with overall or octave band or both. The suggestion from Consultant Komrower is to go with the overall requirements. There are no specifications in the requirements to meet either or both. Mr. Lally communicated that since the table will be included in the bylaw this will assist with compliance and enforcement. There was a question about how do we as a town know when someone is violating this? Consultant Komrower responded that it is the same measurement and it could be verified. If you meet the octave levels, then you will meet the other levels by default. Consultant Wells communicated that this will likely still be complaint based. Mr. Lally explained that this could also be used in permitting applications so that applicants will have to meet the standard and design the facility to meet the standards. This would protect the residents.

The next item discussed was the location of the noise test. There was a suggestion to make it more specific indicating the test would be at the source property line. The proposed wording would be "the closest residential abutter, unless there is reason to believe ambient noise level contributes. Consultant Wells will make the revisions.

ODOR STANDARDS:

The next issues discussed were the odor standards. Consultant Wells informed the Board that since the last meeting, she had added threshold with a complaint component which can be enforced by the Enforcement Officer. If there are five complaints within thirty day, this would trigger enforcement action. There was a comment that the problem with the complaint approach is that people are annoyed by smells at different levels.

Consultant Straughan explained that cannabis odor is unique since the odor comes from the flowering plant which has 60 chemicals within it. Some of the chemical smells can be objectionable to humans in small quantities. He further explained that there is no way you can physically measure by a device to determine the concentrations. Therefore, the human nose is the best detector. There is no way to take the human subjectivity out of this. There was discussion about the Nasal Ranger with the 7 to 1 dilution ratio. It is a good standard tool for certain industries. If the town decides to use a Nasal Ranger, Consultant Straughan recommended that the Town get training; there is a company called St. Crowe Sensory, which offers a certification training which requires recertification every six months. A certification does assist if a case goes to court.

Mr. Lally wanted to know Consultant Straughan's opinion of the study of Globesville, CO which was done in Denver, Colorado. Mr. Lally communicated that the people in this area were victimized and the odor threshold was 7 to 1. The Consultant said he is aware of the study and explained that it was done in 2015 when the odor standards were not in place.

The Chairman communicated that the standard needs to fit many scenarios and not just cannabis. The 7 to 1 standard is there for the Nasal Ranger. Consultant Straughan explained that every industry has different standards based on the type of emissions and the Nasal Ranger helps determine the concentration of what is being omitted, but for cannabis this is completely ineffective. The State of Colorado uses a single standard for the entire state and then applies it across a variety of industries. Therefore, the complaint threshold would be his recommendation. Consultant Straughan further communicated that he never recommended that a specific ratio be used as an absolute standard for a pass/fail. For example, if a certain facility meets the 7 to 1 standard but it still is objectionable to a reasonable person, then there is a problem. The 7 to 1 ratio helps to clarify if someone is a blatant offender.

It was suggested to establish a baseline. The current bylaw has an older standard. Converting the existing detectable level to modern units was discussed but there was a question about if there is a more recent reference than the 1951 chart. There could be tighter controls such as 4 to 1 which would be more stringent, or 2 to 1 which is extremely tighter. If there is a problem at a facility, it would warrant an investigation then the enforcement officer could verify if the owner is complying with the odor control plan. This would include, for example, verifying that the exhaust fans are running and working and making sure the carbon filters are being taken out and replaced. The applicant at 4 Marc Road did provide an odor plan but it needed to be updated with more complete and descriptive language. The odor control plan needs to be part of an application and it must meet the State and DEP standards. The purpose of an odor plan is to completely contain the odor and if correctly implemented, there should be no smell leaving the site.

Mr. Lally advocated for bringing other facilities up to current standards. It was suggested to keep the current standard language and bring in something measurable. Mr. Lally is advocating that you do not need a Nasal Ranger. You just need two people who are reasonable and if they smell it, there is a violation. There is a concern that if there is not something measurable, how do you hold residents to a standard. Mr. Lally communicated that if the Town had a Nasal Ranger setting of 7 in our Bylaws we might be faced with the situation where the Zoning Enforcement Officer would not find any odor at a Nasal Range measure of 7 and residents would be stuck living with this smell. He further expressed that there were several odor complaints, especially Heidi Sia, since her house and rental business are the most “prevailing down-wind” from the 2 Marc Road marijuana cultivation facility. Mr. Lally spoke with the residents on several occasions and depending on the wind direction and facility harvest cycle there is smell from 2 Marc Road. There was a question about if there is a more current concentration list instead of the one from 1951. Consultant Straughan noted that if you were going with that threshold, then you would need to take air samples which would need to be tested and brought to a lab and this would be burdensome on the community. At least with the Nasal Ranger, you apply the same dilution threshold for every industry and it ultimately comes back to the human nose and the current bylaw has language indicating “is to a reasonable person”. There was a comment that if there is not a measurable component, then how can the town hold anyone to a standard.

Consultant Straughan indicated that a few of the ways to control odor would be:

- Dilution

- Molecular filtration
- Ozone – a chemical

There was a suggestion that if there is a complaint then the Zoning Enforcement Officer would do an investigation and determine if there needs to be a corrective measure. This could be achieved by the violator having to apply for a special permit addressing the mitigation measures needed. The burden to fix this would be on the applicant. It was further recommended to leave some quantifying performance standard so that if this goes to court it is measurable.

Recommendations from the discussion were:

- Keep current bylaw.
- Provide guidance to the zoning enforcement officer through special permit process.
- Do further research about getting an updated chart instead of the one from 1951.

Consultant Wells will work with the odor and noise consultants to make the recommended revisions and provide a further revised draft back to the Board.

FUTURE MEETING:

- Tuesday, May 12, 2020

ADJOURN:

On a motion made by Bob Tucker and seconded by Rich Di Iulio, the Board voted by Roll Call vote to adjourn the meeting.

Roll Call Vote:

Rich Di Iulio	**aye**
Bob Tucker	**aye**
Tom Gay	**aye**
Andy Rodenhiser	**aye**
Matt Hayes	**aye**

The meeting was adjourned at 9:53 pm.

Prepared by,
Amy Sutherland
Recording Secretary

Reviewed and edited by,
Susan E. Affleck-Childs
Planning and Economic Development Coordinator

Board Members
Andy Rodenhiser, Chair
Robert Tucker, Vice Chair
Thomas Gay, Clerk
Matthew Hayes, P.E., Member
Richard Di Iulio, Member
Jessica Chabot, Associate Member

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TOWN OF MEDWAY
COMMONWEALTH OF MASSACHUSETTS

PLANNING AND ECONOMIC DEVELOPMENT BOARD

May 12, 2020

Ms. Christine Price
11054 Ventura Boulevard, #103
Studio City, CA 91604

Sent via email 5/12/20

Dear Christine,

I am writing to you as the record owner of property at 1 Nirvana Way in Medway.

I understand that an on-site meeting was held on Friday, May 8, 2020 with Tony Biocchi, as your local representative, and Conservation Commission chairman David Travalini, for purposes of reviewing a building permit application to construct a single-family home at 1 Nirvana Way. The subject property is shown as Lot 10-C an ANR plan endorsed by the Planning and Economic Development Board on August 28, 2018. We further understand there is a purchase and sale agreement between you and Mr. Sean Smith for this property.

While on site, Mr. Biocchi and Mr. Travalini discovered that Mr. Smith had begun some unauthorized site construction work at the Nirvana Way property. Apparently portions of the roadway have been dug and some excavation work has occurred along with land clearing outside the limit of work.

This work is not authorized and does not comply with the conditions specified in the February 2014 Hill View Estates Subdivision Certificate of Action and the *Subdivision Rules and Regulations*. A pre-construction meeting has not been held nor have arrangements been made for the standard oversight and inspection of infrastructure construction by the Board's consulting engineer. Furthermore, no land disturbance permit was applied for or issued by the Town. Please cease all further construction activity until compliance is achieved.

Town staff will determine what is needed in terms of site stabilization to address the extent of unauthorized land disturbance that has occurred.

The Planning and Economic Development Board will be briefed on this matter during its ZOOM meeting on Tuesday, May 12th. I have attached the meeting agenda with the ZOOM access instructions should you wish to attend.

Thank you for your immediate attention to this matter.

Best regards,

Andy Rodenhiser, Chairman

cc: Sean Smith
Tony Biocchi
Glenn Murphy
Bill Sack
Bridget Graziano, Conservation Agent
Beth Hallal,
Jack Mee, Building Commissioner
Barbara Saint Andre, Director of Community and Economic Development

Susan Affleck-Childs

From: Christine . <doyoga@outlook.com>
Sent: Tuesday, May 12, 2020 4:28 PM
To: Susan Affleck-Childs
Cc: Tony Biocchi; Glenn Murphy; ssmith73; Bill Sack; Bridget Graziano; Beth Hallal; Barbara Saint Andre; Jack Mee
Subject: Re: Unauthorized Work at 1 Nirvana Way

Hi Susy,
Thank you.
Believe me; I am shocked, mortified, dismayed, and highly distressed by this.

I wish for it to be clearly on record that I neither had any knowledge of ANY of this, nor was in any way, shape or form, involved in ANY of this.
I do not see any letter in attachment - just the PB agenda??
Am I missing something?
Thank you
Christine

> On May 12, 2020, at 4:04 PM, Susan Affleck-Childs <sachilds@townofmedway.org> wrote:
>
> Hi Christine,
>
> See attached letter from Planning and Economic Development Board Chairman Andy Rodenhiser pertaining to 1 Nirvana Way.
>
> This letter will be forwarded to members of the Planning and Economic Development Board for discussion at tonight's meeting.
>
> Best regards,
> Susy Affleck-Childs
> Susan E. Affleck-Childs
> Planning and Economic Development Coordinator
> Town of Medway Public Schools 155 Village Street
> Medway, MA 02053
> 508-533-3291
>
> <5-12-2020 PEDB mtg agenda (UPDATED 5-8-20).pdf>

Susan Affleck-Childs

From: Lally, John - 0666 - MITLL <jlally@ll.mit.edu>
Sent: Monday, May 11, 2020 6:45 AM
To: Susan Affleck-Childs
Subject: More Env Std discussions
Attachments: 2020_0430_DRAFT_MEDWAY_ENVIRONMENTAL_STANDARDS_DRAFT_JL_Comments_10May2020.docx; MfgChemAssoc_1951_Ref44_Highlighted..pdf; Ref44_Table_III_1951_ChemistAssoc.pdf; AIHA_OdorThresholds_2ndEd_OffWeb.pdf; Industrial odor sources and air pollutant concentrations in Globeville a Denver Colorado neighborhood.pdf

Good morning Susy,

I have some additional updates and clarifications to offer for the continued environmental update discussions, they're all related to odor.

As usual I ask that you please distribute this email and attachments to those involved in the discussions and anyone else as you see fit.

Summary of Additional Updates with Explanations:

1.) When referring to odor thresholds, the industry standard term is "Detection Threshold" not Detectable Threshold. The attached updates have Detectable changed to Detection.

2.) Because the odor bylaw applicability qualifiers of: "Continuous, Frequent or Repetitive", risk exposing Medway residents to episodic odors, such as those generated by Marijuana facilities, I offered to delete those qualifiers. However, that calls into question if odors generated during needed repairs and maintenance (i.e. for septic & sewer systems) would result in a violation. To address that the attached offers to add Repair & Infrequent Maintenance Exclusions.

3.) Rereading the Denver Neighborhood Odor Study it's clear that mixtures of odorants have the potential to cause odor intensities much greater than the intensities caused by individual odorant compounds in isolation. I've added a qualifier that protects Medway Residents from that potential situation.

4.) The AIHA odor threshold tables are comprehensive dating back to the early 1900's, presumably to help folks sort out confusing situations like we're finding ourselves in now. The odor testing standards vary greatly across that time frame and therefore AIHA recommends using only those table values that were determined using methodologies that had equal to or better than the following controls: Measured Delivered Concentration, Used Forced-Choice Methods, Provided Sample Blanks, and Delivered the Odorant such that the person could not dilute the sample. The attached updates add these qualifiers, I tried to take the language pretty much verbatim from the AIHA doc. See the highlighted text on Pg xii (pg 4 of pdf) of AIHA doc attached.
    a. FYI, Table 6.2 of the AIHA reference is a Methods summary for all the Thresholds reported, presumably to assist odor professionals in assessing which thresholds meet these modern testing standards.

Additional clarifications:

1.) I want to be clear that the odor bylaw paradigm I'm intending, is no different than that currently used by the Town for Civil Engineering and Noise compliance and enforcement. That is, Town Staff and officials are not expected to become odor experts versed in the use of: field olfactometers, the nature of odor compounds, odor sampling, testing etc. What I'm advocating for is an odor bylaw that leaves the technical details of odor compliance and enforcement to those professionals with that expert knowledge and who are trained in applying that knowledge. Where the costs of compliance are borne by the applicants and the costs of enforcement are borne by the violators.

2.) Not sure I've adequately explained how I arrived at the conclusion that Medway's existing odor bylaw intends for the odor threshold to be the detection threshold, so I'll explain that now. I simply traversed the various references in the sequence enumerated below. All of the below references except the Medway ZBL are attached with the relevant text highlighted: (NOTE: I recognize the below procedure is rather detailed and may be difficult to follow, nevertheless I encourage those involved to convince themselves that Medway's existing odor bylaw intends for the odor threshold to be the detection level, not only for establishing a baseline for further discussions but to establish the current level of odor protection currently afforded Medway residents).

   a. Medway ZBL, 7.3 D Odors: "No objectionable odor greater than that caused by 0.001201 oz per thousand cubic feet of hydrogen sulfide or any odor threshold as defined in Table III in Chapter 5 of Air Pollution Abatement Manual (copyright 1951 by Manufacturing Chemists Assoc., Inc., Washington, DC) shall be permitted. This brings us to Table III of the 1951 reference coming up in b.), next.
   b. Table III in Chapter 5 of Air Pollution Abatement Manual 1951.
      i. I picked 4 compounds from Table III: Allyl mercaptan, Hydrogen sulfide, Methyl mercaptan, & Thiophenol & identified their reported concentrations in Table III per Reference 44, Katz & Talbert 1930. I then investigated Reference 44 for what odor threshold levels the reported concentrations in the 1951 reference Table III refer to. That brings us to Reference 44 coming up in c.), next.
   c. In Reference 44 Katz & Talbert 1930, Table 3 documents the odor intensities that correspond to the odorant concentrations reported in Table III of the Air Pollution Abatement Manual 1951 (i.e. the reference in the Medway ZBL). For each of the 4 compounds I examined, the reported concentration is that for an odor intensity of "1" as defined in reference 44.
      i. An odor Intensity "1" in Reference 44 is defined as:
         1. "1=Very faint", it's just above "0=No odor"
            a. An Odor Intensity =1 is further described: "No. 1 is the threshold odor, just perceptible"
      ii. At this point I concluded that the odor threshold intended in 7.3.D of the Medway ZBL intends to be the odor detection threshold.
      iii. Then when I found the AIHA odor threshold reference and saw they identified the odor threshold type I wondered if Reference 44 (Katz & Talbert) was included, indeed it is. That takes us to the AIHA reference coming up in d.), next.
   d. In the AIHA odor threshold reference there's a Methods Summary in Table 6.2 that documents the threshold type. Please note in the AIHA reference on pg 63 of PDF (pg 57 of doc), Katz(1930) Threshold Type is identified as "D", which is defined as Detection on pg 52 of pdf (pg 46 of doc). In addition the "Katz & Talbert 1930" thresholds in Table 6.3 are identified as "d" which is defined as Detection on Pg 78 of pdf,(Pg 72 of doc).
      i. The description in Reference 256 on Pg 164 pdf (pg 158 doc) (Katz & Talbert 1930) of the AIHA doc matches the description of Reference 44 (Katz & Talvert 1930) of the 1951 Reference from Medway ZBL, confirming they are indeed using the same reference.
   e. At this point I had become convinced the Medway ZBL odor threshold does indeed intend to be the Detection Threshold.

3.) During the last discussions the question arose whether the failure to remedy the odor issues in the Denver Neighborhood of Globeville were a result of the D/T criteria or a failure to adequately apply the D/T criteria. I reread the peer reviewed study of the Globeville situation with that question in mind, here's what I found:

   a. In the conclusion of that Study: (NOTE: As you read this equate Regulation 2 (Reg 2) as D/T=7, that's the odor threshold in Reg 2.).
      i. "Regulation 2 (Reg 2) is Colorado's current approach to addressing and regulating odors. It has proven ineffective for addressing Globeville's odor events. Despite residents calling and asking for Reg 2 assessments, no violation has been

recorded. For example, one odor event that occurred in September 2011 was reported to CDPHE and investigated by an odor inspector. The wind was out of the WNW at 1-3mph, but odor could not be detected at a dilution of 2:1."   i.e. Not only was odor not detected at D/T=7, when dilution was reduced to D/T=2, the odor still would not have caused a violation.

b. Per Pg 1130 of the Study (pg 5 of pdf):
    i. "Residential samples were collected over a 7-month period". Presumably there was vigilant odor monitoring going on during this study interval and yet per the conclusion no odor violations had been recorded.
c. Also in the conclusion the study points out:
    i. "Numerous variables influence odor detection and therefore determine odor violations: rapidly changing and unpredictable meteorological conditions, individual sensitivity to odors, and mixing in ambient air"
d. In the introduction:
    i. "Initial conversations with elected officials, state health department staff, and others in a regulatory capacity were ineffective due to regulators' unwillingness to assist residents, as well as a lack of data conclusively identifying the odor source"

It seems as though odor phenomena are exceedingly difficult to measure and characterize, and both the D/T criteria and the failure to adequately apply it have been factors over decades. However, even when D/T criteria were applied as prescribed during the study period no odor violations were recorded. In one instance even if the odor threshold was reduced from D/T=7 to D/T=2 no odor violation would have occurred.   This is why I oppose D/T based odor thresholds: They make inherently difficult odor performance standards all the more difficult to enforce and determine compliance, and instead I advocate for the undiluted odor detection threshold.

Respectfully submitted,
John Lally, Resident
35 Coffee Street
Medway, MA 02053

7.3. ENVIRONMENTAL STANDARDS

A. **Purpose**. The intent of this section is to provide standards for uses that may generate impacts that are potentially hazardous, harmful to the environment, disturbing or offensive. Medway Zoning Bylaws, § 5.2, Prohibited Uses, expressly prohibits all uses in any district that pose a present or potential hazard to human health, safety, welfare, or the environment through the emission of smoke, particulate matter, noise or vibration, or through fire or explosive hazard, or light and shadow flicker. Furthermore, Medway Zoning Bylaws, § 5.2, Prohibited Uses, B.14 prohibits any use that produces "disturbing or offensive" noise, vibration, smoke, gas, fumes, odors, dust or other objectionable or hazardous features. For the purposes of this section, "disturbing or offensive" impacts are those that a reasonable person with normal sensitivity would find objectionable, as interpreted by the Building Commissioner/Zoning Officer or his or her designee.

B. **Enforcement**: Medway Zoning Bylaws, § 3.1, Enforcement, Violations, and Penalties authorizes the Building Commissioner to interpret and enforce this Bylaw. In addition, the police department, fire department, or board of health officials are authorized to enforce standards that are based on certain sections of 310 CMR, § 7, Air Pollution Control Regulations. At the discretion of the Building Commissioner/Zoning Enforcement Officer or the Planning and Economic Development Board, a technical consultant may be engaged by the Town of Medway to investigate and document violations.

C. Standards. The following standards shall apply to all districts and shall be determined at the location of use:

1. **Smoke, Fly Ash, Dust, Fume, Vapors, Gases, Other Forms of Air Pollution:** Medway Zoning Bylaw, § 5.2, Prohibited Uses, 14, prohibits any use "that produces disturbing or offensive noise, vibration, smoke, gas, fumes, odors, dust or other objectionable or hazardous features." In addition, all activities involving smoke, fly ash, dust, fume, vapors, gases, other forms of air pollution, as defined in CMR 310, § 7, Air Pollution Control Regulations, as amended, prohibits emissions which can cause damage to human health, to animals or vegetation, or other forms of property, or which cause any excessive soiling at any point.

2. **Noise Disturbance:** No person or persons owning, leasing or controlling the operation of any source or sources of noise shall willfully, negligently, or through the failure to provide necessary equipment or facilities or to take necessary precautions, permit the establishment of a condition of noise pollution. In addition, all activities involving noise must also meet the standards of 310 CMR § 7.10, Air Pollution Control Regulations, as amended, which regulates outdoor noise. 7.10(1) of this regulation prohibits any person owning, leasing, or controlling a source of sound to "cause, suffer, allow, or permit

unnecessary emissions from said source of sound that may cause noise." Nothing in this bylaw prevents the Planning and Economic Development Board from attaching additional conditions relating to noise to their approval of special permit applications.

a. **Continuous Noise**. For the purposes of this bylaw, continuous noise restrictions apply to permanent non-residential installations and home-based businesses where noise is a by-product of business operations (such as from exhaust equipment). Maximum permissible sound pressure levels measured at the property line of the noise source for noise radiated continuously from the noise source ~~between 9 P.M. and 7 A.M~~. shall be as follows:

Octave Band Center Frequency (Hz)	Daytime 7AM to 9PM (dB)	Nighttime 9PM to 7AM (dB)
63	72	~~67~~ **55**
125	60	~~55~~ **48**
250	53	~~48~~ **42**
500	47	~~42~~ **39**
1000	43	~~38~~ **36**
2000	40	~~35~~ **33**
4000	37	~~32~~ **30**
8000	33	~~28~~ **27**
Overall Level dB(A)	**52**	**42**

Compliance with all octave band limits is required. If the enforcement officer determines that the noise source contributes significantly to ambient noise levels at a distance from the property, sound levels may be measured in those locations beyond the source property line. Noise caused by agricultural, farm-related, or forestry-related activities as defined by G.L., c 128, Agriculture, § 1A, as amended, is exempt from this restriction.

b. **Temporary Noise.** For the purposes of this bylaw, non-continuous noise restrictions apply to permanent non-residential installations and home-based businesses where noise is periodically produced. No person shall use or cause the use of any noise-producing equipment or tool (such as for construction, repair or demolition operations) between the hours of 9:00 P.M. and 7:00 A.M. The limitation of this section does not apply to any construction, demolition or repair work on public improvements authorized by a governmental body or agency. Noise caused by agricultural, farm-related, or forestry-related activities as defined by G.L., c 128, Agriculture, § 1A, as amended, is exempt from this restriction.

Commented [LJ-0-M2]: I thought it was the boards consensus to update Night-Time Octave Band Levels based on an overall 42dBA. Updates shown in red are those levels per Jeff's email of 04Mar2020, & the Overall Level in dB(A) added as the last row in the table per Jeff. This last row really helps clarify the confusion that can result regarding what in the Bylaw is dB & what is dB(A).

Commented [LJ-0-M1]: The time interval of 9pm to 7am specified in the text seems to apply to the nature of the noise source, not necessarily defining what hours are Nighttime and Daytime, causing one to have to make an inference. Also, would this mean if the noise source only operated from 10am to 2pm then the levels in the table wouldn't apply because it's operating outside the 9pm to 7am interval specified? Perhaps it would be clearer to add the Nighttime & Daytime hours right in the column headings as shown?

Commented [LJ-0-M3]: Per Jeff, add units in dB for the octave bands & make sure **not** dB(A)

3. **Vibration**: No vibration which is discernible to the human sense of feeling for 3 minutes or more in any hour between 7 A.M. and 7 P.M. or of 30 seconds or more in any one hour from 7 P.M. to 7 A.M. shall be permitted. No vibration at any time shall produce an acceleration of more than 0.1g or shall result in any combination of amplitude and frequencies beyond the "safe" range or Table 7, U.S. Bureau of Mines Bulletin NO. 442. Vibrations resulting from temporary construction activity that occurs between 7:00 A.M. and 9:00 P.M. shall be exempt from this section.

4. **Odors**: ~~Continuous, frequent, or repetitive~~ Objectionable odors may not be produced in any zoning district or impact any public space where people live, work or assemble. No objectionable odor greater than that caused by the lowest odor detection ~~detectable~~ thresholds as listed in the most recent edition of the American Industrial Hygiene Association (AIHA), Odor Thresholds for Chemicals with Established Occupational Health Standards, Reported Odor Thresholds (Eg Table 6.3 in 2nd Edition) shall be permitted. Only those reported detection thresholds determined with equal to or better than the following controls shall apply: Measured delivered concentration, Used force-Choice methods, Provided sample blanks, Delivered the odorant such that the person could not dilute the sample. Due to the potential of odorant mixtures causing more intense odors than individual odorant compounds in isolation, nothing in this bylaw shall be interpreted as allowing for any objectionable odor at or above the detection threshold.: Nothing in this bylaw prevents the Planning and Economic Development Board from attaching additional conditions relating to odor to their approval of special permit applications.

   a. **Non-Residential Uses**. Non-residential uses that produce odors must install and maintain odor-eliminating equipment.

   testing to verify compliance.

   b. **Investigation.** If the Building Commissioner/Zoning Officer determines that an investigation is warranted, an odor observation shall be undertaken to determine if an objectionable odor exists at the property line. Undiluted odor field observations (i.e. sniffing at the property lines) or odor sampling shall be performed at a frequency, duration and property line locations appropriate for the odor source under investigation and any odor complaints that have been received. Field observations must use carbon filtering masks to refresh the olfactory sense between observations (sniffing). Measurements may be done in the field by the zoning enforcement officer or their designee, or using laboratory means and methods.
   ~~Building Commissioner/Zoning Officer or designated staff may use a field olfactometer to observe, document, verify, and enforce odor limits using a "Dilution to Threshold" (D/T) of seven (7) or less at the property line from where the odor is created.~~ Because certain odors cannot be detected by

Commented [LJ-0-M4]: Odor emissions from 2 Marc Rd are episodic, depending upon: grow, harvest, process cycles, weather & seasonal conditions. If this language were present it could be (& likely would be) argued that because the odor emissions aren't continuous & don't occur on a regular schedule that this odor standard doesn't apply to 2 Marc. Rd. I recommend deleting this language & simply state: "Objectionable odors may not be produced".

Commented [LJ-0-M5]: I thought it was the boards consensus to keep quantitative criteria where possible. Consistent with that the precise definition of what objectionable odors are, is defined here. This criteria is consistent with the odor protections currently afforded Medway residents (which is the undiluted *detection* ~~detectable~~ threshold) brought up to modern standards.
This criteria will also provide clear guidance to applicants on what the compliance standard is.
During enforcement this criteria will most likely only come into play when the zoning enforcement officer finds a violation based on undiluted sniffing (observations) at a property line & there's an uncooperative violator. This will provide the zoning enforcement officer with the objective tool needed to compel compliance.

Commented [LJ-0-M6]: Per AIHA important to only use those thresholds that were determined using adequate testing controls.

Commented [LJ-0-M7]: Based on the Denver Neighborhood of Globeville study, when odorants are mixed they can cause more intense odors than the individual compounds in isolation. So important to make sure that situation is covered.

Commented [LJ-0-M8]: What was intended by this sentence fragment? Is this whole compliance section missing? If yes, perhaps adapt the investigation procedure as updated in red below for compliance too.

Commented [LJ-0-M9]: Think it's important to provide some guidance for investigations, and measurement methods.
There should be sufficient latitude for the zoning enforcement officer to tailor the investigation to the particular characteristics of the odor source under investigation & any complaints received.
This could also be adapted for a compliance protocol.

Commented [LJ-0-M10]: The proposed odor threshold is undiluted, so no field olfactometer is needed. All that's needed is a carbon filtering mask to refresh the olfactory sense between sniffs. Carbon filter masks are inexpensive & readily available.

Commented [LJ-0-M11]: Please do not include any reference to Dilution to Threshold criteria. To provide the same level of odor protection as the current odor bylaw, all odor observations must be undiluted. This also saves the expense of the Town having to buy field olfactometers.

mechanical means, the Building Commissioner/Zoning Officer may determine that the odor is one which is objectionable to a reasonable person with normal sensitivity and that the odor source is subject to investigation, violations, penalties, and/or corrective measures.

If the Building Commissioner/Zoning Officer determines that corrective measures are necessary, the owner and/or operator of the odor-producing use must provide the Planning and Economic Development Board with an application and plan for how the odor will become compliant for the Board's consideration of a special permit. If the Town requires consulting assistance to evaluate the application and plan, all costs will be borne by the applicant.

c. **Farming.** Odors resulting from farming practices as defined in Medway General Bylaws, c. 31, § 2, Right to Farm, are exempt.

d. **Residential Use Exemptions**: Should residential exemptions be added?: Barbecues, Wood Stove Exhaust, House painting etc

e. **Repair and Maintenance Exemptions**: Should repair and infrequent maintenance activity exemptions be added, especially for septic & sewer systems.

- Where infrequent is defined as something like: Occurs at intervals of 1year or longer?

Commented [LJ-0-M12]: Should Residential Exemptions be added? I would think Residents would want to be sure the new Env. Stds won't cause violations for: Barbecues, wood stove exhaust, house painting fumes, etc…

Substance	Reference	Location	Concentration	M.A.C.	Comment
Smoke	43	London	0.84 mg./m.³	———	Mean Concn. in winter.
Suspended dust	43	Country air	Usually<0.1 mg./m.³	———	———
Suspended dust	43	Towns of <100,000 population	Usually<0.2 mg./m.³	———	Mean Concn.
Suspended dust	43	Large cities 1,000,000+ population	May be>0.5 mg./m.³	———	———
Suspended dust	43	Heavily industrialized areas	May be> 1.0 mg./m.³	———	———
Total particulate	3	Donora, Pa.	0.0-2.5+ mg./m.³	———	95% of samples had less than 2.5 mg./m.³; 78% of samples had less than 1.0 mg./m.³
Total particulate	12	Cincinnati	0.34 mg./m.³	———	Residential area, 3 Yr. average. 0.191 mg./m.³ in control area.
Total particulate	12	Cincinnati	0.472 mg./m.³	———	Business — Industrial area, 3 Yr. average 0.191 mg./m.³ in control area.
Total particulate	70	Los Angeles	1.5—4.2 mg./m.³ 0.7—1.0 mg./m.³	———	1943. 1947

TABLE III
Odor Thresholds

Compound	Reference	Vapor Concentration p.p.m. (vol.)	mg./1: oz./1000 c.f.
Acetaldehyde	20	0.45	$0.4x10^{-2}$
Acetaldehyde	44	$0.67x10^{-2}$	$0.12x10^{-3}$
Acetaldehyde	6	0.36	$0.65x10^{-3}$
Acetic Acid	6	2.6	$0.65x10^{-1}$
Acetone	6	1.6	$0.38x10^{-2}$
Acrolein	20	17	$0.38x10^{-1}$
Acrolein	44	1.8	$0.41x10^{-2}$
Akrol (mixed turpenes)	20	———	$0.1x10^{-1}$
Allyl alcohol	20	7.1	$0.17x10^{-1}$
Allyl alcohol	44	1.4	$0.33x10^{-2}$
Allyl amine	20	29	$0.67x10^{-1}$
Allyl amine	44	6	$0.14x10^{-1}$
Allyl disulfide	20	$0.17x10^{-1}$	$0.1x10^{-3}$
Allyl disulfide	44	$0.12x10^{-2}$	$0.72x10^{-5}$
Allyl isocyanide	20	1.6	$0.43x10^{-2}$
Allyl isocyanide	44	$0.18x10^{-1}$	$0.49x10^{-4}$
Allyl isothiocyanate	20	0.42	$0.17x10^{-2}$
Allyl isothiocyanate	44	0.15	$0.61x10^{-3}$
Allyl isothiocyanate	4	2	$0.8x10^{-2}$
Allyl mercaptan	20	$0.16x10^{-1}$	$0.5x10^{-4}$
Allyl mercaptan	44	$0.15x10^{-2}$	$0.45x10^{-5}$
Allyl sulfide	20	$0.11x10^{-1}$	$0.5x10^{-4}$
Allyl sulfide	44	$0.14x10^{-3}$	$0.65x10^{-6}$

Compound	Reference	Vapor Concentration	
		p.p.m. (vol.)	mg./1: oz./1000 c.f.
Ammonia	20	53	$0.37x10^{-1}$
Ammonia	67	<5	———
Ammonia	56	53	———
Amyl acetate	4	7	$3.9x10^{-2}$
Amyl alcohol	4	63	$2.25x10^{-1}$
Amyl isovalerate	4	1.7	$1.2x10^{-2}$
Amyl thioether	4	0.2	$1x10^{-3}$
Amylene	20	2.3	$0.66x10^{-2}$
Amylene (mixed)	44	0.19	$0.54x10^{-3}$
Aniline	6	0.23	$0.87x10^{-3}$
Arsine	67	0.5 or less	$0.16x10^{-2}$ or less
Benzaldehyde	20	0.69	$0.3x10^{-2}$
Benzaldehyde	44	$0.42x10^{-1}$	$0.18x10^{-3}$
Benzene	18	$0.42x10^{-1}$	$0.13x10^{-3}$
Benzene	6	1.5	$0.48x10^{-2}$
Benzyl chloride	20	0.31	$0.16x10^{-2}$
Benzyl chloride	44	$0.4x10^{-1}$	$0.21x10^{-3}$
Benzyl mercaptan	20	$0.37x10^{-1}$	$0.19x10^{-3}$
Benzyl mercaptan	44	$0.26x10^{-2}$	$0.13x10^{-4}$
Benzyl sulfide	20	$0.68x10^{-1}$	$0.6x10^{-3}$
Benzyl sulfide	44	$0.66x10^{-2}$	$0.53x10^{-4}$
Bromoacetone	20	0.9	$0.5x10^{-3}$
Bromoacetophenone	20	$0.80x10^{-1}$	$0.65x10^{-3}$
Bromoacetophenone	44	$0.15x10^{-1}$	$0.12x10^{-3}$
Butane	67	5000	12
Butylene, alpha—	44	0.92	$0.21x10^{-2}$
Butylene, beta—	20	26	$0.59x10^{-1}$
Butylene, beta—	44	2.1	$0.48x10^{-2}$
Butylene, gamma—	44	1.3	$0.30x10^{-2}$
n-Butyl mercaptan	20	0.38	$0.14x10^{-2}$
Butyl mercaptan	4	6(?)	$0.18x10^{-1}$
n-Butyl mercaptan	44	$0.49x10^{-1}$	$0.18x10^{-3}$
n-Butyl sulfide	20	0.18	$0.11x10^{-2}$
n-Butyl sulfide	44	$0.15x10^{-1}$	$0.90x10^{-4}$
Butyric acid	56	2.4	$0.9x10^{-2}$
Butyric acid	4	2.4	$0.9x10^{-2}$
Butyric acid	18	$0.83x10^{-3}$	$0.3x10^{-5}$
Carbon bisulfide	20	0.84	$0.26x10^{-2}$
Carbon monoxide	67	Odorless	———
Carbon tetrachloride	58	70	0.44
Carbon tetrachloride	4	718	4.5
Chloroacetophenone	20	1.3	$0.85x10^{-2}$
Chloroacetophenone	44	$0.16x10^{-1}$	$0.10x10^{-3}$
		0.11	$0.70x10^{-3}$
Chlorine	56	3.5	$0.10x10^{-1}$
Chlorine	20	3.5	$0.10x10^{-1}$
Chloroform	4	674	3.3
Chlorophenol	18	$0.33x10^{-2}$	$0.17x10^{-4}$
Chlorophenol	20	$0.34x10^{-1}$	$0.18x10^{-3}$
o-Chlorophenol	44	$0.36x10^{-2}$	$0.19x10^{-4}$
Chlorpicrin	20	1.1	$0.73x10^{-2}$
beta-Chlorovinyldichloroarsine	20	———	$0.14x10^{-1}$
Coumarin	20	$0.57x10^{-1}$	$0.34x10^{-3}$
Coumarin	44	$0.33x10^{-2}$	$0.20x10^{-4}$
Cresol	18	$0.72x10^{-2}$	$0.41x10^{-4}$
Cresol	6	0.19	$0.11x10^{-2}$
Crotonaldehyde	20	7.3	$0.21x10^{-1}$
Crotonaldehyde	44	$0.62x10^{-1}$	$0.18x10^{-3}$

Compound	Reference	Vapor Concentration p.p.m. (vol.)	Vapor Concentration mg./1: oz./1000 c.f.
Crotyl mercaptan	20	0.80×10^{-2}	0.29×10^{-4}
Crotyl mercaptan	44	0.12×10^{-3}	0.43×10^{-6}
		0.40×10^{-3}	0.14×10^{-5}
Cyanogen chloride	20	1	0.25×10^{-2}
Cyanogen chloride	67	1	0.25×10^{-2}
Cyclohexane	67	>300	>1.0
Dichlorodiethyl sulfide	20	0.20	0.13×10^{-2}
Dichlorodiethyl sulfide	44	0.23×10^{-2}	0.15×10^{-4}
1, 2-Dichloroethane	67	100	0.40
Dichloroethylene (Trans.)	20	1.1	0.43×10^{-2}
Dimethyl trithiocarbonate	20	0.32×10^{-1}	0.18×10^{-3}
Dimethyl trithiocarbonate	44	0.58×10^{-2}	0.33×10^{-4}
Dioxane	67	200 or less	0.72 or less
Diphenyl chlorarsine	20	0.25×10^{-1}	0.3×10^{-3}
Diphenyl cyanarsine	20	0.29	0.3×10^{-2}
Diphenylamine chlorarsine	20	0.23	0.25×10^{-2}
Diphenyl ether	20	0.1×10^{-1}	0.69×10^{-4}
Diphenyl ether	44	0.10×10^{-2}	0.70×10^{-5}
Diphenyl sulfide	20	0.63×10^{-2}	0.48×10^{-4}
Diphenyl sulfide	44	0.34×10^{-3}	0.26×10^{-5}
Diphosgene	20	1	0.88×10^{-2}
Dithioethylene glycol	20	0.42	0.16×10^{-2}
Dithioethylene glycol	44	0.31×10^{-1}	0.12×10^{-3}
Ethanol	18	1.9	0.36×10^{-2}
Ethyl acetate	4	190	6.86×10^{-1}
Ethyl dichlorarsine	20	0.14	0.1×10^{-2}
Ethyl ether	6	0.23	0.69×10^{-3}
Ethyl ether	18	0.83	0.25×10^{-2}
Ethyl ether	4	1923	5.83
Ethyl isothiocyanate	20	11	0.38×10^{-1}
Ethyl isothiocyanate	44	1.7	0.61×10^{-2}
Ethyl mercaptan	20	0.75×10^{-1}	0.19×10^{-3}
Ethyl mercaptan	44	0.26×10^{-3}	0.66×10^{-6}
		0.70×10^{-2}	0.18×10^{-4}
Ethyl mercaptan	4	18	4.6×10^{-2}
Ethyl selenide	20	0.12×10^{-1}	0.62×10^{-4}
Ethyl selenide	44	0.12×10^{-2}	0.62×10^{-5}
Ethyl selenomercaptan	20	0.42×10^{-2}	0.18×10^{-5}
Ethyl selenomercaptan	44	0.30×10^{-3}	0.13×10^{-6}
Ethyl sulfide	6	0.56×10^{-4}	0.21×10^{-6}
Ethyl sulfide	44	0.28×10^{-2}	0.10×10^{-4}
Ethyl thioether	4	3	1.2×10^{-2}
Ethylene dichloride	20	6	0.25×10^{-1}
Heptylic acid	6	0.59×10^{-3}	0.19×10^{-4}
Hydrogen cyanide	20	0.9	0.1×10^{-2}
Hydrogen cyanide	67	0.9	0.1×10^{-2}
Hydrogen selenide	67	0.3 or less	0.99×10^{-3} or less
Hydrogen sulfide	67	0.25×10^{-1}	0.35×10^{-4}
Hydrogen sulfide	44	0.13	0.18×10^{-3}
Hydrogen sulfide	20	0.79	0.11×10^{-2}
Hydrogen sulfide	6	1	0.14×10^{-2}
Iodoform	18	0.21×10^{-3}	0.36×10^{-4}
Iodoform	18	0.50×10^{-2}	0.81×10^{-4}
Iodoform	4	1.1	0.18×10^{-1}
Iodoform	56	1.1	0.18×10^{-1}
Isoamyl acetate	44	0.33×10^{-2}	0.18×10^{-4}
Isoamyl acetate	20	0.11	0.6×10^{-3}
Isoamyl alcohol	6	0.26×10^{-3}	0.94×10^{-6}

Compound	Reference	Vapor Concentration p.p.m. (vol.)	mg./1: oz./1000 c.f.
Isoamyl isovalerate	20	0.11	0.8x10^{-3}
Isoamyl isovalerate	44	0.66x10^{-2}	0.46x10^{-4}
Isoamyl mercaptan	44	0.43x10^{-3}	0.18x10^{-5}
Isoamyl mercaptan	20	0.7x10^{-1}	0.3x10^{-3}
Isoamyl sulfide	44	0.30x10^{-2}	0.21x10^{-4}
Isoamyl sulfide	20	0.42x10^{-1}	0.3x10^{-3}
Isobutyl alcohol	6	0.30x10^{-2}	0.90x10^{-5}
Isobutyl mercaptan	4	3.5(?)	8x10^{-3}
Mercaptans (some)	56	3.3x10^{-5}	0.4x10^{-7}
Methanol	6	410	0.53
Methane	67	Odorless	———
Methyl anthranilate	20	0.59x10^{-1}	0.37x10^{-3}
Methyl anthranilate	44	0.94x10^{-2}	0.58x10^{-4}
Methyl dichlorarsine	20	0.46x10^{-1}	0.8x10^{-3}
Methyl isothiocyanate	4	5	1.5x10^{-2}
Methyl mercaptan	20	0.56	0.11x10^{-2}
Methyl mercaptan	44	0.41x10^{-1}	0.81x10^{-4}
Methyl salicylate	4	16	1x10^{-1}
Methyl sulfide	20	0.43	0.11x10^{-2}
Methyl sulfide	44	0.37x10^{-2}	0.94x10^{-5}
Methyl thiocyanate	20	3.2	0.96x10^{-2}
Methyl thiocyanate	44	0.25	0.75x10^{-3}
Naphthalene	67	$<$25	$<$1.3
Nitrobenzene	44	1.9	0.96x10^{-2}
Nitrobenzene	4	2.9	1.46x10^{-1}
Nitrobenzene	20	6	0.3x10^{-1}
Nitrogen dioxide	67	$<$5	$<$0.94x10^{-2}
Nonylic acid	6	0.29x10^{-2}	0.19x10^{-4}
Ozone	67	0.15x10^{-1}	0.29x10^{-4}
Ozone	20	0.51	0.1x10^{-2}
Oxidized oils	20	———	0.11x10^{-2}
Phenol	6	0.29	0.11x10^{-2}
Phenol	18	1	0.38x10^{-2}
Phenyl isocyanide	44	0.10x10^{-2}	0.42x10^{-5}
Phenyl isocyanide	20	0.69x10^{-2}	0.29x10^{-4}
Phenyl isocyanide	4	0.5	0.2x10^{-2}
Phenyl isothiocyanate	44	0.94x10^{-1}	0.52x10^{-3}
Phenyl isothiocyanate	20	0.43	0.24x10^{-2}
Phosgene	20	1.1	0.44x10^{-2}
Phosgene	56	5.6	0.23x10^{-1}
Phosphorus	67	———	0.1x10^{-2} or less
Propane	67	20,000	36
Propanol	6	1.9	0.48x10^{-2}
Propargyl aldehyde	44	0.16	0.35x10^{-3}
Propioaldehyde	20	1	0.22x10^{-2}
Propionic acid	6	0.15x10^{-1}	0.45x10^{-4}
n-Propyl mercaptan	44	0.16x10^{-2}	0.5x10^{-5}
Propyl mercaptan	20	0.24x10^{-1}	0.75x10^{-4}
Propyl mercaptan	4	2	6x10^{-3}
n-Propyl sulfide	44	0.11x10^{-1}	0.53x10^{-4}
n-Propyl sulfide	20	0.17	0.81x10^{-3}
Pyridine	18	0.32x10^{-3}	0.10x10^{-5}
Pyridine	6	0.11x10^{-1}	0.35x10^{-4}
Pyridine	18	0.33x10^{-1}	0.11x10^{-3}
Pyridine	44	0.23	0.74x10^{-3}
Pyridine	20	1.1	0.37x10^{-2}
Pyridine	4	10	0.32x10^{-1}
Skatole	18	0.33x10^{-6}	0.18x10^{-8}

Compound	Reference	Vapor Concentration p.p.m. (vol.)	mg./1: oz./1000 c.f.
Skatole	18	0.30x10^{-5}	0.16x10^{-7}
Skatole	44	0.19x10^{-1}	0.10x10^{-3}
Skatole	20	0.22	0.12x10^{-2}
Sulfur dioxide	56	3.0	0.78x10^{-2}
Thiocresol	20	0.2x10^{-1}	0.1x10^{-3}
p-Thiocresol	44	0.27x10^{-2}	0.14x10^{-4}
Thiophenol	44	0.26x10^{-3}	0.12x10^{-5}
Thiophenol	20	0.14x10^{-1}	0.62x10^{-4}
Toluene	6	0.48	0.18x10^{-2}
Trichlorofluoromethane	67	200,000	1120.
2, 4, 6-Trinitro-tert-butyl-xylene	44	0.51x10^{-4}	0.59x10^{-6}
Trinitrobutylxylene	20	0.87x10^{-3}	0.1x10^{-4}
Valeric acid	4	7	2.9x10^{-2}
Vanillin	18	0.17x10^{-6}	0.11x10^{-8}
Xylene	6	0.17	0.73x10^{-2}

TABLE IV

Concentrations of Substances Causing Pain in the Eyes

Substance	Reference	Irritating Concentration p.p.m. (vol.)	mg./1: oz./1000 c.f.
Acetaldehyde	44	11,000	20
Acetone	64	500	1.2
Acrolein	41	3.06	0.7x10^{-2}
Acrolein	21	0.5-1.5	0.115x10^{-2}— 0.34x10^{-2}
Acrolein	44	12	0.27x10^{-1}
Allyl alcohol	44	59	0.14
Allyl amine	44	140	0.33
Allyl disulfide	44	6.4	0.38x10^{-1}
Allyl isothiocyanate	44	4.2	0.17
Allyl mercaptan	44	150	0.45
Allyl sulfide	44	1,400	6.5
Benzaldehyde	44	3.8	0.16x10^{-1}
Benzyl bromide	41	0.57	0.4x10^{-2}
Benzyl chloride	44	8.0	0.41x10^{-1}
Benzyl iodide	41	0.22	0.2x10^{-2}
Benzyl mercaptan	44	7.5	0.38x10^{-1}
Brominated ketones	41	———	0.12x10^{-2}
Bromoacetone	41	0.27	0.15x10^{-2}
Bromoacetophenone	44	0.38x10^{-1}	0.31x10^{-3}
Bromobenzyl cyanide	41	0.19x10^{-1} 0.37x10^{-1}	0.15x10^{-3} 0.30x10^{-2}
Bromomethylethyl ketone	41	0.26	0.16x10^{-2}
Bromopicrin	41	2.46	0.3x10^{-1}
n-Butanol	64	50	0.18
Butanone	64	350	1.01
Butyl-amyl acetate	64	300	———
Chloroacetone	41	4.75	0.18x10^{-1}
Chloroacetophenone	41	0.48x10^{-1}	0.3x10^{-3}
Chloroacetophenone	44	0.83x10^{-2}	0.52x10^{-4}
Chloromethyl chloroformate	41	0.38	0.2x10^{-2}
o-Chlorophenol	44	130	6.8
Chloropicrin	41	0.29—2.8	0.2—1.9x10^{-2}

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in parts per million the figures are: Ionone, 0.0000059; and apiol, 63,000. Threshold concentrations determined by the authors lie within this range.

In general, the earlier investigators employed methods based on disseminating a weighed or measured volume of vapor in a flask or in a box of known volume; then the nose was inserted through a temporary opening to smell. Zwaardemaker [5] used a cubical box of glass and metal of 64 liters capacity. Residual odors were dispelled after a test by removing a side to air out the box and scour the inside surfaces with chalk.

In 1920 an odor scale of five degrees of increasing intensities was devised and used by Katz and Allison.[6] They also developed an apparatus or odorimeter for determining weights of vapors volatilized at uniform rates and diluting the vapors to various concentrations by means of measured streams of air. These methods were followed in the present investigation.

In 1898, Gamble [7] proved that Weber's law applies to the sense of smell; this law [8] states that the sense reaction is proportional to the logarithm of the stimulus. These relations have been found to hold for the sense of smell, also for nasal irritation and eye irritation throughout the investigations reported herein.

SCALES FOR MEASURING ODORS AND IRRITATIONS

The scale of odor intensities used in this investigation consists of zero and five degrees of intensity, thus:

0 = No odor.
1 = Very faint.
2 = Faint.
3 = Easily noticeable.
4 = Strong.
5 = Very strong.

The scale of irritation of nose and eyes devised for present purposes has four degrees above zero, as follows:

0 = No irritation.
1 = Faint.
2 = Moderate.
3 = Strong.
4 = Intolerable.

The numerals indicate uniform increments in odor or irritation; the words corresponding aim to describe the subjective effects. Qualities of odors, as pleasant or repulsive, are not considered; the degrees are conceived equal, regardless of the qualities of various odors or those of irritations. The odor scale has more divisions over its range than the irritation scale, as the sense of smell can doubtless perceive small differences more readily than can the sense of irritation.

ODORIMETER

Figure 1 shows the essential parts of the odorimeter diagrammatically. The arrows point the flow of the air, which is rendered originally odorless with activated charcoal. Dry air from the pri-

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[7] Gamble, Eleanor A. M., The applicability of Weber's Law to Smell: Am. Jour. of Psychology, vol. 10, 1898, pp. 82–142.
[8] James, Wm., The Principles of Psychology: H. Holt & Co., New York City, 1890, 2 vols. (Weber's law is considered in vol. 1, pp. 537–49.) Weber's Law, New International Encyclopedia: Vol. 23, 1925, pp. 428–429.

ing material in the nose; thus it can easily be conceived that some sort of additional reaction takes place and that directly the osmoceptor in the nose becomes saturated no further reaction is possible and no further odor can be appreciated until fresh osmoceptor is formed. Ruzicka suggested two such osmoceptors are involved since substances inspired in a concentrated state have odors different to those perceived in a dilute condition.

For these reasons the observers testing the odors and other effects were exposed to the substances only during the limited time of observation—an inhalation for odor and nasal irritation, and 10 seconds exposure for eyes. Irritants affect the nose and eyes variously. Some irritate almost immediately on short exposure, and the irritation quickly disappears after exposure. The effects of others is delayed; for example, the irritation by allyl alcohol is not apparent until several seconds after exposure. Some substances cause slowly increasing irritation after exposure until a maximum is perceived; the intensity then decreases. Crotonaldehyde is an example.

In general, it was found that irritants did not give strong odors. Unpleasant odors or stenches may be very faint or very strong; pleasant odors are not very strong, and if they increase to very strong they become repulsive.

USE OF SCALES FOR MEASURING INTENSITIES OF ODORS AND IRRITATIONS

The arbitrary scales adopted for measuring the odors, nasal irritations, and eye irritations afford a means of comparing the effects of different chemicals at any concentration in air. It would be convenient to measure odors by some physical method apart from the senses of persons, but that is now unattained. The degrees of the odor scale were explained to the subjects in terms of the sense of smell thus: 0, Or no odor, requires no amplification; No. 1 is the threshold odor, just perceptible. Consider now the opposite end of the scale. No. 5, or very strong, is the most intense odor without regard to quality and perceived aside from any other physiological effects such as irritation or nausea. No. 3, or easily noticeable, is the median odor midway between Nos. 1 and 5. No. 2, or faint, is conceived as midway between Nos. 1 and 3; similarly No. 4, or strong, is conceived as midway between Nos. 3 and 5.

With this scale the observers recorded their impressions of odor intensities. They might not agree closely, but it is found that with a number of observers and taking averages of results of observations satisfactory measurements can be made.

In explanation of the scale of nasal irritations No. 1, or slight, is the threshold irritation, just perceptible, not painful; No. 3, or strong, is painful, exceedingly discomforting, yet it may be endured voluntarily by the observer; No. 2, or moderate, is midway between Nos. 1 and 3 and is very unpleasant; and No. 4, or intolerable, is exceedingly painful, so painful that it can not be voluntarily endured.

The scale of eye irritation is explained as above, but whereas a single inhalation sufficed to determine odor or nasal irritation, eye irritation was determined by exposing the eye for 10 seconds (estimated by counting) to an air stream bearing the chemical. It was permissible for an observer to wink involuntarily, provided that the eye was opened again. When the eye was closed involuntarily and could

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INTENSITIES OF ODORS VERSUS CONCENTRATIONS IN PARTS PER MILLION

TABLE 3.—*Intensities of odors versus concentrations, parts per million*

Test No.	Material	Intensity of odor, degree						Dilution factor
		0	1	2	3	4	5	
	Hydrocarbons							
74	Alpha butylene	0.060	0.92	14	210	3,300	[2] 50,000	15
72	Beta butylene	.17	2.1	26	330	4,000	[2] 50,000	12
73	Gamma butylene	.080	1.3	22	360	6,000	[2] 100,000	17
71	Amylene (mixed isomers)	.015	.19	2.3	29	360	[2] 4,500	12
	Alcohol							
8	Allyl alcohol	.29	1.4	7.2	36	180–1,400		5.0
	Esters							
35	Isoamyl acetate	.000095	.0033	.11	3.8	130	4,500	34
66	Isoamyl isovalerate	.00040	.0066	.11	1.8	30		17
61	Methyl anthranylate	.0015	.0094	.059	.37	[2] 2.3		6.3
	Aldehydes							
44	Acetaldehyde	.0020	.066	2.2	73	2,400	[2] 80,000	33
40	Benzaldehyde	.0025	.042	.71	12	200		17
6	Acrolein	.19	1.8	17	160	[2] 1,500		9.4
5	Crotonaldehyde (commercial)	.63	3.5	20	110	[2] 630		5.6
54	Crotonaldehyde	.010	.062	.39	2.4	15		6.2
25	do	.018	.20	2.3	26	[2] 290		11
55	do.[1]				50			
17	Propargyl aldehyde	.025	.16	1.0	6.8–450			6.5
	Amine							
7	Allyl amine	1.3	6.2	29	140	650	3,100	4.7
	Isocyanides							
23	Phenyl isocyanide	.00010	.0010	.010	.11	1.1	11	10
16	Allyl isocyanide	.0020	.018	.16	1.4	12	110	8.9
	Nitro compounds							
1	Nitrobenzene	.62	1.9	5.9	18	55	170	3.1
65	2:4:6 Trinitrotertiarybutylxylene (artificial musk)	.0000030	.000051	.00088	.015			17
62	do	.00000030	.0000065	.00014	.0030			22
	Cyclic nitrogen compounds, carbon, hydrogen, and nitrogen							
22	Pyridine	.025	.23	2.0	18	170	1,500	9.0
10	Skatole	.0016	.019	.23	2.8			12
	Miscellaneous carbon, hydrogen and oxygen compounds							
60	Diphenyl ether	.00010	.0010	.010	.10	1.0	10	10
69	Coumarin	.00020	.0033	.055	.90			17
	Mercaptans							
46	Methyl mercaptan	.0030	.041	.57	7.9	110	1,500	14
2	Ethyl mercaptan	.000021	.00097	.045	2.1	97	4,500	46
29	do	.0000060	.00026	.011	.49	21	920	43
49	do	.00010	.0030	.088	2.6	78	2,300	30
51	do.[3]	[2] .00030	[2] .0070	.16	3.8	90	2,100	23
32	N-Propyl mercaptan	.00011	.0016	.024	.36	5.4	81	15
3	N-Butyl mercaptan (war gas)	.0027	.048	.84	15	260	4,600	18
42	N-Butyl mercaptan	.000045	.0010	.022	.50	11	250	22
28	Isoamyl mercaptan	.000022	.00043	.0083	.16	3.1	60	19
36	Benzyl mercaptan	.00018	.0026	.038	.55	8.0		15
43	Dithio ethylene glycol	.0023	.031	.41	5.6	75	1,000	13
11	Thiophenol	.0000050	.00026	.014	.72	38	2,000	52

[1] Starting with No. 2 or moderate eye irritation.
[2] Extrapolated value.
[3] Starting with No. 2 or faint odor.

TABLE 3.—*Intensities of odors versus concentrations, parts per million*—Continued

Test No.	Material	Intensity of odor, degree						Dilution factor
		0	1	2	3	4	5	
	Mercaptans—Continued							
30	P-Thiocresol	0.00035	0.0027	0.020	0.16	1.2–280	----------	7.6
19	Allyl mercaptan	.00046	.0015	.0047	.015	3.6	----------	3.2
31	do	.0012	.0059	.029	.14	.70	[2] 600	4.9
20	Crotyl mercaptan	.0000030	.00012	.0048	.19	7.6–120	----------	40
64	do	.000015	.00040	.011	.28	7.6	200	27
	Thioethers, polysulphide, and thioester							
56	Hydrogen sulphide	.022	.13	.77	4.6	27	----------	5.9
4	Methyl sulphide (commercial)	.0010	.027	.73	20	530	14,000	27
70	Methyl sulphide	.00016	.0037	.084	1.9	44	1,000	23
34	Ethyl sulphide	.00011	.0028	.069	1.7	44	1,100	25
59	N-Propyl sulphide	.00070	.011	.17	2.5	39	600	15
37	N-Butyl sulphide	.0012	.015	.19	2.6	31	400	13
38	Isoamyl sulphide	.00021	.0030	.044	.63	9.0	130	14
47	Benzyl sulphide	.00050	.0060	.071	.85	----------	----------	12
68	Diphenyl sulphide	.000018	.00034	.0064	.12	2.3	[2] 43	19
27	Allyl sulphide	.0000020	.00014	.010	.71	50	3,600	71
67	Allyl disulphide	.000080	.0012	.17	.24	3.5	50	14
57	Dimethyl trithiocarbonate	.00085	.0058	.40	.28	1.9	[2] 13	6.9
	Thiocyanate and isothiocyanates							
21	Methyl thiocyanate	.019	.25	3.2	42	540	7,000	13
13	Ethyl isothiocyanate	.27	1.7	11	68	430	----------	6.3
14	Phenyl isothiocyanate	.020	.094	.44	2.1–64	----------	----------	4.7
12	Allyl isothiocyanate	.054	.15	.42	1.2–94	----------	----------	2.8
	Halogenated hydrocarbon							
58	Benzyl chloride	.0050	.040	.32	2.6	21	[2] 170	8.1
	Halogenated ketones							
39	Bromacetophenone	.0027	.015	.082	.45	----------	----------	5.5
15	Chloracetophenone	.0045	.016	.059	.21	[2] .77	----------	3.6
18	do.[4]	.0020	.11	6.2	----------	----------	----------	56
33	do.[5]	.010	.051	.26	1.3	----------	----------	5.1
50	do	.0031	.028	.25	[2] 2.3	----------	----------	9.1
52	do	[2] .014	.039	.11	.30	[2] .84	----------	2.8
	Halogenated phenol							
63	O-Chlorphenol	.00040	.0036	.033	.30	2.7	25	9.1
	Halogenated thioether							
45	Bis alpha dichlorethyl sulphide	.00020	.0023	.026	.30	3.5	40	11
	Seleno mercaptan and seleno ether							
48	Ethyl seleno mercaptan	.000023	.00030	.0038	.050	.64	8.3	13
26	Ethyl selenide	.00012	.0012	.011	.11	1.0	10	9.6

[2] Extrapolated value.
[4] 60-second exposure with face in a wooden box.
[5] 10-second exposure with face in a wooden box.

Odor Thresholds

for Chemicals with Established Occupational Health Standards

Second Edition

Edited by

Sharon S. Murnane, CIH, CSP

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ISBN-13: 978-1-935082-38-5
Stock Number: AEAR13-108

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Introduction

This report is intended to serve as a chemical odor threshold reference for use by industrial hygienists and other health or safety professionals.

There are a number of threshold value compilations available.[1-8] Some transform the original data for use while others record the range of threshold values. In the original AIHA® publication, critiquing the experimental odor threshold determinations reported in literature provided a basis for developing an estimate of odor threshold and represented the data available in odor threshold compilations at the time.[9]

The second edition presents a range of odor threshold values for 295 odorant chemicals for which there is a published occupational exposure limit in the United States. There were 182 chemicals in the original publication. The references used for occupational exposure levels are the OSHA Permissible Exposure Limits (PELs)[10], ACGIH® Threshold Limit Values (TLVs®)[11] and AIHA® Workplace Environmental Exposure Levels® (WEELs).[12] The listing of odorous chemical thresholds contained in this report is by no means a comprehensive compilation of all odorous chemicals or odor threshold data. The *Compilation of Odor Thresholds in Air and Water*, published by Gemert 2011, is a comprehensive source of peer reviewed research for 1921 chemicals with reported odor thresholds in air.[1] This document is the major basis for sources of odor threshold data reviewed in this publication. In addition, a thorough literature review was conducted that incorporated additional citations for thresholds, methods, variables, and human factors.

Odor threshold research is an advancing science. As the technology of olfactometry and analytical measurement advances, threshold experiments are conducted and reported in the literature. The result is that any threshold compilation can be slightly outdated at the time of its publication. Historically and even today many of the published odor threshold values suffer due to the lack of control of important variables. You may readily find detection thresholds with several orders of magnitude for the same chemical. This leads to skepticism and lack of confidence in the results. Recent research shows much of the variability is due to lack of control of the odorant dilution, measuring the odorant's airborne concentration at the person, delivery of 'blanks' to the person to control for false positive responses, delivering enough air to the person so no over-breathing dilution occurs, and use of 'forced-choice' responses. Lack of control over these variables generally leads to higher threshold values than reality. For example, if not enough odorant airflow is delivered to the person and over-breathing dilution occurs, the person would have noticed the odorant at lower concentrations than actually inhaled. Some researchers have found human odor thresholds can be highly reliable, reproducible, and with low variance if the important variables are controlled.[13] To generalize, it has been suggested that the most accurate estimate of a chemical's odor detection threshold would tend to be the lowest concentration reported using good methodology. If one is the use the lowest value published, the study thus reporting this concentration should at least have measured the delivered concentration, used force-choice methods, provided sample blanks, and delivered the odorant such that the person could not dilute the sample.

Section 1 has information on the anatomy and physiology of odor perception. Section 2 presents material on odor perception and odor properties. Section 3 discusses the role of odor perception in occupational and environmental settings. In Section 4 a review of odor threshold methodology is given. Section 5 describes the literature search and review procedure conducted in the original publication. Section 6 presents the data tables of odor threshold values and associated information.

Preface

Estimates of odor threshold are still important to industrial hygiene, occupational safety, air pollution control and ventilation engineering. Since the original AIHA® publication on Odor Thresholds, there have been sufficient changes in testing methodology, Threshold Limit Values (TLVs®) and odor perception research to indicate a need for a revision.

An extensive literature review and critique occurred in the original publication. For the second edition, the literature examination consisted of a methods review for those articles that could be acquired. Numerous publications in odor research have been published in the years since the original AIHA® book. Where there were several references supporting the same information on odor variability, it was decided to cite the most current references in this second edition.

The range of odor threshold values can be broad in some cases, so it is appropriate as stated in the original publication, to use caution in relying on odor alone as a warning of potentially hazardous exposures. This edition is meant to provide the industrial hygiene practioner with insight into the variables that affect the human perception to chemical odors in the occupational environmental and incorporate new odor threshold data. Further, the use of descriptive statistics, as in the original publication, was outside the scope and purpose of this edition, due in large part to the limitation of comparable data and multiple experimental methods used.

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Table of Contents

1. Anatomy and Physiology of Odor Perception

Olfaction is the sense of smell. It depends on the interaction between the odor stimulus and the olfactory epithelium. Two olfactory organs are located in the nasal cavity on either side of the nasal septum. Air is drawn into the nose, where it swirls around the nasal cavity. Such turbulent action causes airborne compounds to contact the olfactory organs. The compounds must diffuse into the mucus where they stimulate the olfactory receptors. Olfactory receptors contain neurons with cilia protruding from the surface. Chemicals interact with the receptors sending a response to the cerebral cortex in the brain.[14]

A human has about 10–20 million olfactory receptors; but human olfactory sensitivities and receptor area do not compare with other vertebrates like dogs, cats or fishes. While the human olfactory system is very sensitive, the activation of an olfactory receptor does not necessarily lead to sensory perception or awareness of the odorant. Inhibitions along the olfactory pathway can stop the sensations from reaching the olfactory cortex in the brain. Olfactory stimulation reaches the cerebral cortex without synapsing in the thalamus, like all other sensory information. This can lead to intense responses to certain odorants both emotionally and behaviorally.

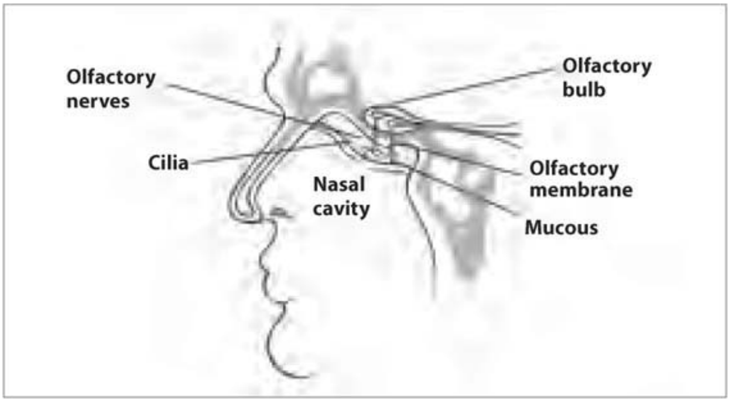

Figure 1.1. Anatomy of Smell.
http://www.atsdr.cdc.gov/HAC/landfill/html/ch3.html

Odor adaptation occurs when a person becomes accustomed to an odor. The detection threshold increases with adaptation. Adaptation will occur differently with each odorant. Odor fatigue occurs with prolonged exposure and when total adaptation has occurred.[15]

2. Odor Perception

A brief review of the sensory properties of odor and some of the attributes of human olfactory response is presented to facilitate understanding of odor threshold values.

2.1 Dimensions of Odor

An **odorant** is any substance that can elicit an olfactory response. Odor is the sensation created by stimulating the olfactory organs. The sensory perception of odorants has four major dimensions: **threshold, intensity, character, and hedonic tone**.[9]

Odor threshold (detectability), in general, is the lowest concentration of gas or a material's vapor that can be detected by odor. The detection threshold is the lowest concentration of odorant that will elicit a sensory response in a human subject without any requirements to identify or recognize the odorant. The recognition threshold is the minimum concentration that is identified or recognized as having a characteristic odor quality.

Threshold values are not fixed physiological parameters or physical constants but are statistical points representing the best estimate value from a group of individual responses.

Odor intensity refers to the perceived strength of the odor sensation. Intensity increases as a function of concentration. Odor intensity is the perceived strength of an odor above its threshold.[9]

Two formulae; Steven's Law[9] and Weber-Fechner Law[16], can be used to develop a mathematical relationship between intensity and concentration.

Steven's Law: The relationship of perceived strength (intensity) and concentration is expressed as a psychophysical power function as follows:

$$\mathbf{S = KI^n} \qquad \mathbf{(1)}$$

Where
S = perceived intensity of sensation;
I = physical intensity of stimulus (odorant concentration);
n = slope of psychophysical function; and
K = y-intercept.

The slope and intercept of a function vary with type of odorant. This has important implication for the perception and control of odors. Odors with high slope values dissipate more quickly with dilution and, consequently, are easier to eliminate or control. Odors with low slope values are more difficult to eliminate as they are perceivable at lower levels of concentration.

Weber-Fechner Law: The principle that the intensity of a sensation varies by a series of equal arithmetic increments as the strength of the stimulus is increased geometrically.

$$\mathbf{I = K_w log(C/C_o) + const} \qquad \mathbf{(2)}$$

I = Intensity (perceived strength), dimensionless
$\mathbf{K_w}$ = Weber-Fechner constant
C = Concentration of odorant
$\mathbf{C_o}$ = Concentration of odorant at the detection threshold
Const = a constant which relates to the use of mean intensity levels.

Odor character is what the substance smells like. American Society for Testing and Materials (ASTM) publication (ASTM data series DS 61, 1985)[(16)] presents character profiles for 180 chemicals using a 146-descriptior scale. The scale includes such terms as "fishy", "hay", "nutty", "creosote", "turpentine", "rancid", "sewer", 'ammonia", bananas, etc.

Odor character descriptors in Tables 6.1 & 6.4 are based on reports in the *Atlas of Odor Character Profiles*[(17)] and the scientific or peer reviewed literature.[(18-23)] The intensity level at which the character is determined is seldom given in the sources reviewed. Since odor character can change with intensity, it should be remembered that the character reported may differ from source to source. The purpose here is to include an observation on the odorant character that may accompany the threshold value.

Hedonic tone is a category of judgment of the relative pleasantness or unpleasantness of an odor. Perception of hedonic tone is influenced by subjective experience, frequency of occurrence, odor character, odor intensity, and duration.(9) Perceptions vary widely from person to person and are strongly influenced by external factors (i.e. emotions, previous experience, etc.).[(15)]

2.2 Properties of Olfactory Functioning

Human response to odorant perception follows a number of characteristic patterns associated with sensory functioning. The insensitive range includes people who are anosmic (unable to smell) and hyposmic (reduced ability to smell). The sensitive range includes people who are hyperosmic (acute sense of smell) and people who are sensitized to a particular odor through repeated exposure.

Odor sensitivity is not constant across odorants or individuals. A person may be hyposmic to one odorant and hyperosmic to another.[(9)] Anosmia is the permanent loss of the sense of smell. One study reported anosmics do not automatically have anosmia or a diminished detection threshold to the other chemical studied.[(24)] It is very rare to find individuals who have diminished thresholds for all compounds. Ansomics who have diminished odor detection may not necessarily have diminished recognition threshold. An investigation into the relationship between odor sensitivity and quality found these to be independent for several classes of organics.[25]

Another sensory property of odor that can cause confusion is organoleptic (i.e. sensory as opposed to analytical) odor identification. Organoleptic odorants are those whose odor character changes with concentration. For example, butyl acetate has a sweet odor at low concentrations, taking on its characteristic "banana oil" odor at higher intensities.[9]

2.3 Variability of Olfactory Perception.

When evaluating odor concerns, the industrial hygienist should understand the importance of variability in odor perception, detection and recognition caused by human factors, environmental factors and chemical properties.

2.3.1. Individual (Human) Factors.

The large variability of odor perception among individuals can be influenced by such factors as: smoking habits, concomitant chemical exposures, gender, age, medical diagnosis, etc.[15]

Gender. Numerous studies have found no significant gender-difference in the detection thresholds of various types of odorants.[26-33] Two studies found women were better at recognizing an odorant versus men, but in general, the men could be taught (reminded) of an odorant and show improved recognition of that odorant.[34,35] Hormonal activities (ovulation, pregnancy) can make women more sensitive to odorants.[36-39] One study found women rated sulfur dioxide as having stronger nasal irritation than men.[40]

Age. Numerous studies have observed a decrease in the ability to detect odors as age increases.[27,30,35,41-50] Children have lower odor thresholds than adults. One study found no different in age-related odor threshold differences for sulfur dioxide.[40]

Smoking. Smokers show higher odor detection threshold levels than non-smokers for almost all odorants, but there are a few exceptions.[27,51,52] A study found smokers detection threshold to be higher for nicotine, but not menthol, even when smokers abstained a day before testing.[53] An investigation of smokers' odor thresholds to Phenyl Ethyl Alcohol (found in smoke) and n-butanol (not found in smoke) found a decreased sensitivity to both odorants, thus suggesting odor impairment beyond the compounds present in the smoke.[54]

Physical/Medical State. The physical and mental state of an individual may influence how that individual detects and odor.

- People with multiple chemical sensitivity (MCS) feel they have a greater than normal olfactory sensitivity to odors. Odor threshold testing showed no significant difference as compared to a normal control group.[55]

- An association has been found between odor detection threshold and degree of dementia and rate of dementia progression in Alzheimer disease cases. Some clinics have used odor detection screening as a means to identify individuals who may be at initial stages of Alzheimer's disease.[56]
- Exposure to the World Trade Center air pollution from the 9/11 attack, has been associated with a decrease in the ability to identify odors.[57]
- An odor detection and identification evaluation comparing visually-blind to control subjects found the former have poorer detection thresholds but better identification likelihood.[58]

Detection, Recognition and Irritation. In general odor detection correlates with odor concentration, while odor irritation correlates with vapor pressure. Irritation levels are usually orders of magnitude higher than the odor detection threshold levels.[32,59-65]

2.3.2 Environmental Factors.

If industrial workers are routinely exposed to chemicals their ability to detect odors and their irritation levels can be affected. Research has shown that most of the time, exposed workers will demonstrate a loss in odor detection ability and odor sensitivity when compared to un-exposed workers. Possible causal factors are odor adaptability and olfactory fatigue.[66-73]

2.3.3 Odorant Chemical Properties

Molecular structure. Odor thresholds are affected by molecular size, carbon chain length and functional groups.[74,75] Odor thresholds decrease with increasing molecular size until a plateau is reached and then the trend reverses to increasing odor thresholds with increase in molecular size. This trend has been found in several chemical groups: acetates[76], alcohols[77], acetate esters[78], ketones[79], alkylbenzenes[80], aliphatic aldehydes[81], and carboxylic acids.[82]

Mixture Studies. Perception of a mixture of odorants is very different from how each component chemical would be perceived independently. Odorants can act as additive agents, counteractants, masking agents, or be synergistic.[83,84] In general, Odor detection thresholds, nasal irritation, and eye irritation thresholds appear to be lowered for the mixtures relative to the individual chemical components.[85-93] The mixture contained two compounds, and the one with the higher sorption rate was perceived as more dominate during high-velocity sniffing.[83] Another similar study with odorants above detection thresholds found mixture intensity to be less than additive but lower. Furthermore, by changing the proportions of the mixture, the researchers found the strongest component over-shadowed the other as if the brain filters and removes the smaller component's contribution.[84]

3. Role of Odor Perception in Occupational Settings

3.1 Indoor Air Quality

Odor perception is very subjective. What one person finds disagreeable, another may find the odor neutral or agreeable to them. Although the toxic effects are important, it is the odors that tend to be related to poor or inadequate indoor air quality and are frequently the most important factor triggering complaints. Since the establishment of air quality standards and improvements in ventilation, odors have become unexpected for most nonindustrial indoor environments.(94) Consequently, unexpected odors in usually clean indoor environments have been known to elicit complaints by the occupants. For example; because of the ban on cigarette smoking in most U.S. buildings, the presence of cigarette smoke inside a building may result in occupant complaints because the odor is perceived as offensive.(95)

Odor can be used as a very rough indication of the concentration of a pollutant in the environment. For those pollutants that have an odor threshold either close to or above that for the irritant and/or health effects concentrations, perception of the odor provides an indication of a problem. In most cases, though, the odor threshold is well below the concentration known to cause irritation or other health effects. The challenge for industrial hygienists comes when people's perception is, that they are being harmed even at the odor level.(95)

3.2. Respirator Use

Under the OSHA Respiratory Protection standard, odor thresholds can no longer be used as the primary indicator for changing out respirator cartridges.(96) Odor thresholds can be helpful as a secondary indicator for cartridge change out, if the odorant has sufficient warning properties.(97)

Warning properties of gases and vapors involve odor, taste and/or irritation to indicate the presence of a chemical. A chemical is considered to have poor warning properties if the odor, taste, or irritation effect is not detectable at or below the occupational exposure limit. Odor thresholds are often used as warnings that a respirator cartridge is nearing the end of its service life. Odor thresholds should be used with care because they rely on human response, and there is a wide range of values reported in the literature. If odor thresholds are used as part of a change out procedure, it is important that users are adequately trained on what to do if they detect chemical breakthrough while using a respirator.(93)

Used in conjunction with end of service life indicators, change out schedules, employee training, etc., odor thresholds can still provide useful information to an industrial hygienist in respirator use and selection.

3.3. Workplace and Environmental Exposure Assessments

In the workplace and the environment, a person can sometimes feel the presence of an odor to be an indicator of the presence of a toxic material that will impact their health. It is a challenge for industrial hygienists to make the distinction between the levels of a chemical that result in an odor detected and levels that cause harmful effects.[16]

Factors that may influence workplace odor complaints:

- Frequency of the odor occurrence
- Intensity
- Duration of the exposure
- Offensiveness of the odor (subjective)
- Location of the odor

Some environmental situations that can involve odor perception and thresholds:

- Community protection from existing odorous facilities, investigations of complaints
- Proposed erection of odorous facilities near populated areas.
- Assessing odor arising from site remediations
- Assessing plant emissions and permit compliance

Odor threshold values are a tool along with toxicity data, analytical data, and other industrial hygiene exposure information that can assist the industrial hygienist in evaluation of an exposure situation.

4. Odor Threshold Methodology

4.1 Odor Measurement Standards and Methods[98-100]

Dilution to Threshold Method. A test panel is presented a series of samples increasing in odor concentration; starting below the detection threshold. Multiple presentations are made at each level of dilution. Dilution to threshold method is the most widely accepted method at the current time.

Forced-Choice Method. Trained panel members receive odorous samples among clean samples. Test subjects are required to identify the presence of an odor. The detection threshold is the level at which a panelist can tell the difference between the diluted odorant and the clean sample.

Olfactometry. Olfactometers are instruments that, used with a human subject, detect and measure ambient odors. An operator controls the sample delivery while the test subject inhales through a sniffing port to detect the presence of odor. Most olfactometers are used in a laboratory setting, but a portable unit The Nasal Ranger® (St. Croix Sensory, St. Elmo, MN) is available for field use.

Other Methods. An electronic nose is currently in use by food, beverage and perfume industries. Although the electronic nose may appear to be less sensitive that olfactometry, there is a potential for use in odor evaluation.[101] The Japanese Triangle odor bag[74], squeeze bottles[102], essence cards[103], and vapor delivery device 8[13,104] are other methods currently used in odor research.

Field Measurement Methods. There have been efforts to do field measurements of odors, usually, for evaluating public-exposure environmental sources. A field evaluation of two methods of determining odor concentrations from mink farms found the portable dynamic olfactometer, Nasal Ranger, compared favorably to approximations using the psychophysical Weber-Fechner equation.[105]

4.2 Variability of Threshold Values

Some factors that may affect threshold measurement include stimuli flow rate, olfactometric systems, age and type of panelist, instruction and threshold procedure, and panelist's experimental experience.[106]

- A panelist's performance in detecting odors is relative to the true concentration delivered. Therefore, it is important to accurately measure odorant concentration in any detection threshold evaluation.[107]
- Olfactory fatigue is the temporary, normal inability to distinguish a particular odorant after a prolonged exposure to that airborne compound. Olfactory fatigue can occur in a short period of time depending on the odorant.[70,73]
- Untrained participants had higher detection thresholds than trained/experienced panelists. The untrained participants gradually lowered their detection thresholds through the exposure trials over time.[47]
- Olfactometers should deliver a high enough flow rate to overcome subjects' ability to 'over-breathe' the odorant and dilute it.[108]
- The type of solvent used for dilution of the odorant is important, so the diluent does not interfere with the odor detection results.[109]
- Regarding the presentation method, a study compared detection thresholds to phenyl ethyl alcohol (PEA) using both the staircase paradigm and a constant stimuli method of presenting dilutions in random succession. In a staircase paradigm odorant concentrations are presented in fixed step concentrations sized either increasing or decreasing intervals until the panelist responds. The constant method odorant concentrations are presented in a random order. This study found no significant difference in PEA detection thresholds using these methods, and the constant stimuli method saved some time.[110]

- The persons conducting the odor measurements can influence the results and conclusions from the same environmental situation.[111]

4.3 Modeling

Modeling techniques for determining odor detection and eye and nasal irritation thresholds are being developed and refined. Algorithm equations that correlate well with odor thresholds have been developed to help estimate odor thresholds in the absence of actual odor measurements.[75,112-114] Hundreds of measured odor detection thresholds, verified by the best researchers, were compared to the model estimates. Correlation coefficients above 0.7, sometimes as high as 0.9, were determined. These models have included various classes of volatile organic compounds. One of these models, based upon gas to condensed phases, has these independent variables: solute excess molar refractivity, solute dipolarity/polarizability, hydrogen bond acidity and basicity, and gas to hexadecane partition coefficient. These independent variables have been obtained from experimental data. To simplify matters researchers have found three of these five variables can be combined into one independent variable for a class of organic molecule. Furthermore, researches have determined the value of this constant for several different classes of VOC spanning hundreds of compounds. Overall, the efforts to develop models to estimate detection thresholds have been impressive, and recent research continues to add to the models' validity.

4.4 Criteria for Review of Odor Threshold Measurement Technologies

In the original publication, odor threshold measurement methods were evaluated in terms of their conformity to the following criteria.[9]

The Panel. The panel size should be at least six per group. Panelist selection is based on odor sensitivity to the chemical odorants in question. Panel odor sensitivity (panel calibration) should be measured over time to monitor individual discrepancies and to maintain panel consistency.

Presentation Apparatus. Vapor modality is in the form of a gas-air mixture or vapor over an aqueous solution and is determined by the test purpose and in turn determines the presentation method. Diluent should be consistent with the chemical compounds tested and should not influence odor perception. Presentation mode should minimize additional dilution (ambient) air intake. Analytic measurement should accurately measure the concentration of odorant as it reaches the panelist. Calibration flow rate and face velocity are important system calibrations. Flow rate of odorant should be of sufficient volume to stimulate fully the olfactory receptors. The face velocity at which the odorant is flowed at the panelist should be maintained at a flow barely perceptible by the panelist.

Presentation Method. Threshold type maybe either detection or recognition. Concentration presentation is important because olfactory adaptation occurs rapidly.

Presenting concentrations in ascending order (from weaker to stronger) or allowing for long periods between exposures are common methods to control for adaptation. Trials should be repeated for reliability. Forced Choice Procedure minimizes anticipation effects for thresholds by eliminating false positive responses. Concentration steps of odorants should be presented successively at concentration intervals no more than three times the preceding one.

5. The Literature Search and Review

In the 1989 edition of this publication, odor threshold values and references were reviewed as shown in Table 5.1.

Table 5.1. Code nomenclecture from the 1989 edition

Code	Description
A	Accepted value based on critique
B	Rejected value based on critique
C	Rejected source based on review: • Secondary Source Code – Secondary sources identified as papers in which an odor threshold value, noticeable odor or detectable odor is mentioned, but either is not determined experimentally or is not referenced in the paper. • Incidental Reference – Incidental reference is different than secondary source in that experimental work was conducted but not with odor thresholds • Passive Exposure – Workplace – A study conducted in the work environment to determine worker exposure levels to a variety of substances and differing concentration levels. • Passive Exposure – Experiment – Test chamber experiments designed to determine the permissible limits of worker exposure to various substances.
D	Omitted Sources: • Unpublished Data • Personal Communication • Anonymous References • Omitted References per Gemert 1982 • Pre-1900 References • References with compounds that do not have TLVs
E	Sources not Reviewed – Foreign language articles Sources not Acquired – Old, foreign periodicals or theses

As in the 1989 publication, this second edition established the use of the Gemert compendium and it updates as the major reference source. The reader should keep in mind two considerations. First, the compilation of odor threshold values truly is a formidable task encompassing both an interdisciplinary and world-wide search. Second, although the Gemert compendium does not attain perfection as a source, it is by far the best compendium of threshold values published to date. Gemert has collected data, from a wide variety of countries; extracted thresholds from a wide variety of disciplines (e.g., industrial hygiene, psychology, sensory evaluation, food technology, clinical medicine, air pollution control, engineering, chemistry); and encompassed a century of research.

For the second edition, the literature examination consisted of a methods review for those articles published after 1989 that could be acquired. References were not critiqued as in the original publication because the authors chose to report all of the data available and suggest the use of the lowest value when needed. The object of this edition was to provide more education on odor thresholds through information on the anatomy and physiology, explanation of the variability in obtaining thresholds, and emerging technology in odor measurements. Industrial Hygienists should use their professional judgment and use the odor information presented appropriately.

6. Tables

Data tables begin after the references used in the text portion. A range of odor threshold values and occupational exposure limits are in Table 6.1. Table 6.2 is contains the methods summary information from the acquired articles that were reviewed for this edition. Table 6.3 is all of the published odor threshold values for the 295 chemicals with occupational exposure values. Table 6.4 allows the user to find chemicals by a description of the odor character. Table 6.5 allows the user to find a chemical name by a synonym. Table 6.6 allows the user to find a chemical by Chemical Abstract Number (CAS).

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Table 6.1 – Odor Threshold Values

The table contains the following information:

Chemical Name, CAS Number, Chemical Formula, Chemical Molecular weight"

- Range of Referenced Values
- Odor Character Description(s)
- ACGIH® Threshold Limit Value (TLV)®
- OSHA Permissible Exposure Limit (PEL)
- AIHA® WEEL® Value

Abbreviations/Definitions used in table:

- Alliaceous – Resembling garlic or onion in smell or taste
- BEI – Biological Exposure Indices
- DSEN – May cause dermal sensitization
- Empyreumatic – Being or having an odor of burnt organic material as a result of decomposition
- Etherous / Ethereal – Resembling or pertaining to ether
- Fusel – Hot acrid oily liquid
- H – Aerosol only
- IFV – Measured as Inhalable fraction and vapor
- L – Exposure to carcinogens should be kept to a minimum
- Q – Absorbed rapidly through the skin in molten/heated liquid form in amounts that have caused rapid death in humans
- SEN – Sensitization
- Skin – Potential exposure by the cutaneous route
- (W) – Worker exposure by all routes should be minimized to the fullest extent possible

Table 6.1 – Odor Threshold Values

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	Range of Odor Values (ppm)	Odor Character	ACGIH TLV® (ppm)	OSHA PEL (ppm)	AIHA WEEL® (ppm)
1	**Acetaldehyde** *75-07-0* C_2H_4O *44.05*	0.0015 – 1,000	pungent, fruity, suffocating, fresh, green	C = 25	TWA = 200	–
2	**Acetic Acid** *64-19-7* $C_2H_4O_2$ *60.05*	0.0004 – 204	pungent, vinegar	STEL = 15 TWA = 10	TWA = 10	–
3	**Acetic Anhydride** *108-24-7* $C_4H_6O_3$ *102.09*	0.12 – 0.36	sour, acid	TWA = 1 C = 3	TWA = 5	–
4	**Acetone** *67-64-1* C_3H_6O *58.08*	0.40 – 11,745	sweet, fruity, etherous	TWA = 500 STEL = 750 BEI	TWA = 1,000	–
5	**Acetonitrile** *75-05-8* *C2H3N* *41.05*	13 – 1,161	etherish	TWA = 20 Skin	TWA = 40	–
6	**Acetophenone** *98-86-2* C_8H_8O *120.15*	0.00024 – 0.59	sweet, almond, pungent, oranges, river water	TWA = 10	–	TWA = 10
7	**Acetylene** *74-86-2* C_2H_2 *26.02*	226 – 2584	gassy, garlic	Simple Asphyxiant	–	–
8	**Acrolein** *107-02-8* C_3H_4O *56.06*	0.0036 – 1.8	pungent	C = 0.1 Skin	TWA = 0.1	–
9	**Acrylic Acid** *79-10-7* $C_3H_4O_2$ *72.06*	0.092 – 1.0	rancid, plastic, sweet	TWA = 2 Skin	–	–
10	**Acrylonitrile** *107-13-1* C_3H_3N *53.06*	1.6 – 22	onion, garlic	TWA = 2 Skin	TWA = 2 Skin	–
11	**Allyl Alcohol** *107-18-6* C_3H_6O *58.08*	0.51 – 35	mustard	TWA = 0.5 Skin	TWA = 2 Skin	–
12	**Allyl Chloride** *107-05-1* C_3H_5Cl *76.53*	0.48 – 5.9	pungent	TWA = 1 STEL = 2 Skin	TWA = 1	–
13	**Allyl Isothiocyanate** *57-06-7* C_4H_5NS *99.15*	0.0091 – 1.97	irritating	–	–	STEL = 1 Skin DSEN

Table 6.1 – Odor Threshold Values, cont.

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	Range of Odor Values (ppm)	Odor Character	ACGIH TLV® (ppm)	OSHA PEL (ppm)	AIHA WEEL® (ppm)
14	**Ammonia** *7664-41-7* NH_3 *17.03*	0.043 – 60.3	pungent, irritating	TWA = 25 STEL = 35	TWA = 50	–
15	**n-Amyl Acetate** *628-63-7* $C_7H_{14}O_2$ *130.18*	0.007 – 43	banana, etherous	TWA = 50 STEL = 100	TWA = 100	–
16	**Aniline** *62-53-3* C_6H_7N *93.12*	0.012 – 10	pungent, oily, empyreumatic	TWA = 2 Skin BEI	TWA = 5 Skin	–
17	**Arsine** *7784-42-1* AsH_3 *77.93*	<1.0	garlic	TWA = 0.005	TWA = 0.05	–
18	**Benzaldehyde** *100-52-7* C_7H_6O *106.12*	0.0015 – 783	bitter almond, fruit, vanilla	–	–	TWA = 2 DSEN
19	**Benzene** *71-43-2* C_6H_6 *78.11*	0.47 – 313	aromatic, sweet, solvent, empyreumatic	TWA = 0.5 STEL = 2.5 Skin, BEI	TWA = 1	–
20	**Benzoyl Chloride** *98-88-4* C_7H_5ClO *140.56*	0.0021 – 0.0063	pungent	C = 0.5	–	C = 5 Skin, DSEN
21	**Benzyl Acetate** *140-11-4* $C_9H_{10}O_2$ *150.17*	0.00016 – 22	pears, plastic, etherous, anise	TWA = 10	–	–
22	**Benzyl Chloride** *100-44-7* C_7H_7Cl *126.58*	0.041 – 0.046	pungent	TWA = 1	TWA = 1	–
23	**Biphenyl** *92-52-4* $C_{12}H_{10}$ *154.2*	0.00052 – 0.0095	pleasant, butter-like	TWA = 0.2	TWA = 0.2	–
24	**Boron Trifluoride** *7637-07-2* BF_3 *67.82*	1.5	pungent	C = 1	C = 1	–
25	**Bromine** *7726-95-6* Br_2 *159.83*	<0.0099 – 0.99	alliaceous, sharp, irritating	TWA = 0.1 STEL = 0.2	TWA = 0.1	–
26	**Bromoform** *75-25-2* $CHBr_3$ *252.77*	0.19 – 15	chloroform, sweet, suffocating	TWA = 0.5	TWA = 0.5 Skin	–

Table 6.1 – Odor Threshold Values, cont.

#	Compound Name *CAS Number* *Formula* *Molecular Weight*	Range of Odor Values (ppm)	Odor Character	ACGIH TLV® (ppm)	OSHA PEL (ppm)	AIHA WEEL® (ppm)
27	**1,3-Butadiene** *106-99-0* C_4H_6 *54.09*	0.099 – 76	aromatic, rubber	TWA = 2	TWA = 1 STEL = 5	–
28	**Butane, all isomers** *106-97-8, 75-28-5* C_4H_{10} *58.12*	0.421 – 5,048	natural gas	STEL = 1,000	–	–
29	**Butenes, all isomers** *106-98-9, 107-01-7, 590-18-1* *624-64-6, 25167-67-3, 115-11-7* C_4H_8 *56.11*	0.362 – 2,126	petroleum	TWA = 250	–	–
30	**2-Butoxyethanol** *111-76-2* $C_6H_{14}O_2$ *118.17*	0.08 – 0.35	sweet, ester, musty	TWA = 20 BEI	TWA = 50 Skin	–
31	**2-Butoxyethyl Acetate** *112-07-2* $C_8H_{16}O_3$ *160.21*	0.107 – 0.99	fruity	TWA = 20	–	–
32	**n-Butyl Acetate** *123-86-4* $C_6H_{12}O_2$ *116.16*	0.00013 – 368	sweet, banana	TWA = 150 STEL = 200	TWA = 150	–
33	**sec-Butyl Acetate** *105-46-4* $C_6H_{12}O_2$ *116.16*	0.0025 – 4.76	fruity	TWA = 200	TWA = 200	–
34	**tert-Butyl Acetate** *540-88-5* $C_6H_{12}O_2$ *116.16*	0.008 – 1.31	mild	TWA = 200	TWA = 200	–
35	**n-Butyl Acrylate** *141-32-2* $C_7H_{12}O_2$ *128.17*	0.00029 – 0.101	sweet, rancid, plastic	TWA = 2 SEN	–	–
36	**n-Butyl Alcohol** *71-36-3* $C_4H_{10}O$ *74.12*	0.0033 – 990	sweet, malty, alcohol, medicinal	TWA = 20	TWA = 100	–
37	**sec-Butyl Alcohol** *78-92-2* $C_4H_{10}O$ *74.12*	0.043 – 94	sweet, malty alcohol	TWA = 100	TWA = 150	–
38	**tert-Butyl Alcohol** *75-65-0* $C_4H_{10}O$ *74.12*	3.3 – 957	sweet alcohol	TWA = 100	TWA = 100	–

Table 6.1 – Odor Threshold Values, cont.

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	Range of Odor Values (ppm)	Odor Character	ACGIH TLV® (ppm)	OSHA PEL (ppm)	AIHA WEEL® (ppm)
39	**n-Butylamine** *109-73-9* $C_4H_{11}N$ *73.14*	0.08 – 13.9	sour ammonical	C = 5 Skin	C = 5 Skin	–
40	**n-Butyl Lactate** *138-22-7* $C_7H_{14}O_3$ *146.21*	0.0000000049	mild	TWA = 5	–	–
41	**Butyl Mercaptan** *109-79-5* $C_4H_{10}S$ *90.19*	0.0000027 – 4.9	skunk	TWA = 0.5	TWA = 10	–
42	**p-tert-Butyl Toluene** *98-51-1* $C_{11}H_{16}$ *148.24*	<5.031	gasoline	TWA = 1	TWA = 10	–
43	**Butyraldehyde** *123-72-8* C_4H_8O *72.11*	0.0003 – 5.09	pungent	–	–	TWA = 25
44	**Camphor, synthetic** *76-22-2* $C_{10}H_{16}O$ *152.23*	0.0026 - 7.2	camphorous	TWA = 2 STEL = 3	TWA = 0.321	–
45	**Caprolactam** *105-60-2* $C_6H_{11}NO$ *113.16*	0.065	mild	TWA 1.08 IFV	–	–
46	**Carbon Dioxide** *124-38-9* CO_2 *44.01*	39,000 – 600,136	–	TWA = 5000 STEL = 30000	TWA = 5000	–
47	**Carbon Disulfide** *75-15-0* CS_2 *76.14*	0.016 – 32	vegetable, sulfide, medicinal	TWA = 1 Skin BEI	TWA = 20 C = 30	–
48	**Carbon Tetrachloride** *56-23-5* CCl_4 *153.84*	1.68 – 720	sweet, ethereal, dry cleaner, aromatic	TWA = 5 STEL = 10 Skin	TWA = 10 C = 25	–
49	**Carbonyl Sulfide** *463-58-1* COS *60.08*	0.057 – 0.102	unpleasant	TWA = 5	–	–
50	**Chlorine** *7782-50-5* Cl_2 *70.91*	0.021 – 4.9	suffocating, sharp, bleach	TWA = 0.5 STEL = 1	C = 1	–
51	**Chlorine Dioxide** *10049-04-4* ClO_2 *67.46*	15	chlorine	TWA = 0.1 STEL = 0.3	TWA = 0.1	–

Table 6.1 – Odor Threshold Values, cont.

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	Range of Odor Values (ppm)	Odor Character	ACGIH TLV® (ppm)	OSHA PEL (ppm)	AIHA WEEL® (ppm)
52	**2-Chloroacetophenone** *532-27-4* C_8H_7ClO *154.59*	0.016 - 0.111	fruity	TWA = 0.05	TWA = 0.05	–
53	**Chlorobenzene** *108-90-7* C_6H_5Cl *112.56*	0.087 - 13	almond-like, shoe polish	TWA = 10 BEI	TWA = 75	–
54	**Chlorodifluoromethane** *75-45-6* $CHClF_2$ *86.47*	200,192	ethereal	TWA = 1,000	–	–
55	**Chloroform** *67-66-3* $CHCl_3$ *119.38*	0.102 – 1,413	sweet, etherous, suffocating	TWA = 10	C = 50	–
56	**Chloropicrin** *76-06-2* CCl_3NO_2 *164.38*	1.09	chlorine	TWA = 0.1	TWA = 0.1	–
57	**b-Chloroprene** *126-99-8* C_4H_5Cl *88.54*	0.11 – 276	rubber	TWA = 10 Skin	TWA = 25 Skin	–
58	**Chlorotoluene, o-isomer** *95-49-8* C_7H_7Cl *126.58*	0.18 – 0.270	aromatic	TWA = 50	–	–
59	**Citral** *5392-40-5* $C_{10}H_{16}O$ *152.23*	0.000024 – 0.032	lemon, flowery, citrous	TWA = 5 IFV, Skin SEN	–	–
60	**Cresol, all isomers** *1319-77-3, 95-48-7* *108-39-4, 106-44-5* C_7H_8O *108.13*	0.00005 – 0.0090	creosote, phenol, irritating, smoky, empyreumatic, burnt plastic	TWA = 4.5 IFV, Skin	TWA = 5 Skin	–
61	**Crotonaldehyde** *4170-30-3, 123-73-9* C_4H_6O *70.09*	0.02 – 0.59	pungent	C = 0.3 Skin	TWA = 2	–
62	**Cumene** *98-82-8* C_9H_{12} *120.19*	0.008 – 1.3	sharp	TWA = 50	TWA = 50 Skin	–
63	**Cumene Hydroperoxide** *80-15-9* $C_9H_{12}O_2$ *152.19*	0.0048	sharp, irritating	–	–	TWA = 1 Skin
64	**Cyanogen** *460-19-5* *CN* *26.02*	>500	almonds	TWA = 10	–	–

Table 6.1 – Odor Threshold Values, cont.

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	**Range of Odor Values** (ppm)	**Odor Character**	**ACGIH TLV®** (ppm)	**OSHA PEL** (ppm)	**AIHA WEEL®** (ppm)
65	**Cyanogen Chloride** *506-77-4* *CClN* *61.47*	0.994	acid	C = 0.3	–	–
66	**Cyclohexane** *110-82-7* C_6H_{12} *84.16*	0.52 – 784	pungent	TWA = 100	TWA = 300	–
67	**Cyclohexanol** *108-93-0* $C_6H_{12}O$ *100.16*	0.058 – 0.491	camphorous	TWA = 50 Skin	TWA = 50	–
68	**Cyclohexanone** *108-94-1* $C_6H_{10}O$ *98.14*	0.052 – 219	sweet, sharp	TWA = 20 Skin	TWA = 50	–
69	**Cyclohexene** *110-83-8* C_6H_{10} *82.14*	0.18	sweet	TWA = 300	TWA = 300	–
70	**Cyclohexylamine** *108-91-8* $C_6H_{13}N$ *99.17*	2.42	ammonia	TWA = 10	–	–
71	**Cyclopentadiene** *542-92-7* C_5H_6 *66.1*	1.8	terpene-like, pine, fruit	TWA = 75	TWA = 75	–
72	**Decaborane** *17702-41-9* $B_{10}H_{14}$ *122.31*	0.06	pungent	TWA = 0.05 STEL = 0.15 Skin	TWA = 0.05 Skin	–
73	**1-Decene** *872-05-9* $C_{10}H_{20}$ *140.27*	6.45	pleasant	–	–	TWA = 100
74	**Diacetone Alcohol** *123-42-2* $C_6H_{12}O_2$ *116.16*	0.27 – 13	sweet	TWA = 50	TWA = 50	–
75	**Diacetyl** *431-03-8* $C_4H_6O_2$ *86.09*	0.000002 – 2.9	pleasant, buttery	TWA = 0.01 STEL = 0.02	–	–
76	**Diallylamine** *124-02-7* $C_6H_{11}N$ *97.16*	2	disagreeable	–	–	TWA = 1 Skin
77	**Diborane** *19287-45-7* H_6B_2 *27.69*	1.8 – 3.5	repulsive	TWA = 0.1	TWA = 0.1	–

Table 6.1 – Odor Threshold Values, cont.

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	Range of Odor Values (ppm)	Odor Character	ACGIH TLV® (ppm)	OSHA PEL (ppm)	AIHA WEEL® (ppm)
78	**2,3-Dibromo-1-Chloropropane** *96-12-8* C_3H_5BrCl *236.33*	0.01 – 0.031	irritating	–	TWA = 0.001	–
79	**Dibutylamine** *111-92-2* $C_8H_{19}N$ *129.24*	0.079 – 0.770	amine	–	–	C = 5 Skin
80	**Dibutyl Phthalate** *84-74-2* $C_{16}H_{22}O_4$ *278.34*	0.023	–	TWA = 0.44	TWA = 0.44	–
81	**Dichloroacetic Acid** *79-43-6* *C2H2Cl2O2* *128.94*	0.044	–	TWA = 0.5 Skin	–	–
82	**Dichlorobenzene, o- isomer** *95-50-1* $C_6H_4C_{l2}$ *147.01*	0.02 – 50	camphor	TWA = 25 STEL = 50	C = 50	–
83	**Dichlorobenzene, p-isomer** *106-46-7* $C_6H_4Cl_2$ *147.01*	0.121 – 15	camphor, mothballs	TWA = 10	TWA = 75	–
84	**Dichlorodifluoromethane** *75-71-8* CCl_2F_2 *120.91*	199,790	ethereal	TWA = 1,000	TWA = 1,000	–
85	**1,1-Dichloroethane** *75-34-3* $C_2H_4Cl_2$ *98.97*	49 – 1,359	chloroform, aromatic	TWA = 100	TWA = 100	–
86	**1,2-Dichloroethylene, all isomers** *156-60-5, 156-59-2, 540-59-0* $C_2H_2Cl_2$ *96.94*	277	pleasant	TWA = 200	TWA = 200	–
87	**2,4-Dichlorophenol** *120-83-2* $C_6H_4Cl_2O$ *163*	0.000041	medicinal, phenolic, leather-like, fish sauce	–	–	TWA = 1 Skin, Q
88	**1,3-Dichloropropene** *542-75-6* $C_3H_4Cl_2$ *110.97*	<0.99	sweet, pungent	TWA = 1 Skin	–	–
89	**Dicyclopentadiene** *77-73-6* $C_{10}H_{12}$ *132.21*	0.00019 – 0.02	sweet, sharp	TWA = 5	–	–

Table 6.1 – Odor Threshold Values, cont.

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	Range of Odor Values (ppm)	Odor Character	ACGIH TLV® (ppm)	OSHA PEL (ppm)	AIHA WEEL® (ppm)
90	**Diethanolamine** *111-42-2* $C_4H_{11}NO_2$ *105.14*	0.279	ammonia, amine, rotten fish	TWA = 0.2 IFV Skin	–	–
91	**Diethylamine** *109-89-7* $C_4H_{11}N$ *73.14*	0.0033 – 14.3	musty, fishy, amine	TWA = 5 STEL = 15	TWA = 25	–
92	**2-Diethylaminoethanol** *100-37-8* $C_6H_{15}ON$ *117.19*	0.01 – 0.25	amine, sharp, ammoniacal	TWA = 2 Skin	TWA = 10 Skin	–
93	**Diethylbenzenes, mixed isomers** *25340-17-4, 135-01-3* *105-05-5, 141-93-5* $C_{10}H_{14}$ *134.22*	0.00038 – 0.071	–	–	–	TWA = 5
94	**Diethyl Ketone** *96-22-0* $C_5H_{10}O$ *86.13*	0.85 – 14	acetone, fingernail polish remover	TWA = 200 STEL = 300	–	–
95	**Diethyl Phthalate** *84-66-2* $C_{12}H_{14}O_4$ *222.24*	0.036 – 0.363	–	TWA = 0.55	–	–
96	**Diisobutyl Ketone** *108-83-8* $C_9H_{18}O$ *142.24*	<0.103 – 1.6	peppermint	TWA = 25	TWA = 50	–
97	**Diisopropylamine** *108-18-9* $C_6H_{15}N$ *101.19*	0.014 – 4.2	amine, fishy	TWA = 5 Skin	TWA = 5 Skin	–
98	**N,N-Dimethylacetamide** *127-19-5* C_4H_9NO *87.12*	48	faint, ammonia	TWA = 10 Skin BEI	TWA = 10 Skin	–
99	**Dimethylamine** *124-40-3* C_2H_7N *45.08*	0.00076 – 4.2	ammoniacal, rotten fish	TWA = 5 STEL = 15	TWA = 10	TWA = 1
100	**Dimethylaniline** *121-69-7* $C_8H_{11}N$ *121.18*	0.001 – 0.2	oily	TWA = 5 STEL = 10 Skin BEI	TWA = 5 Skin	–
101	**Dimethyl Disulfide** *624-92-0* $C_2H_6S_2$ *94.2*	0.00029 – 1.45	garlic, putrid, asparagus	TWA = 0.5 Skin	–	–
102	**Dimethyl Ether** *115-10-6* C_2H_6O *46.07*	161 – 228	ethereal	–	–	TWA = 1,000

Table 6.1 – Odor Threshold Values, cont.

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	**Range of Odor Values** (ppm)	**Odor Character**	**ACGIH TLV®** (ppm)	**OSHA PEL** (ppm)	**AIHA WEEL®** (ppm)
103	**Dimethyl Formamide** *68-12-2* *C_3H_7ON* *73.09*	0.047 – 100	fishy	TWA = 10 Skin BEI	TWA = 10 Skin	–
104	**1,1-Dimethylhydrazine** *57-14-7* *$C_2H_8N_2$* *60.1*	<0.31 – 14	fishy	TWA = 0.01 Skin	TWA = 0.5 Skin	–
105	**Dimethyl Sulfide** *75-18-3* *C_2H_6S* *62.13*	0.00012 – 8.11	disagreeable, asparagus, putrid	TWA = 10	–	–
106	**4,6-Dinitro-o-Cresol** *534-52-1* *$C_7H_6N_2O_5$* *198.13*	0.00049 - 0.00259	–	TWA = 0.025 Skin	TWA = 0.025 Skin	–
107	**1,4-Dioxane** *123-91-1* *$C_4H_8O_2$* *88.1*	0.8 – 2609	sweet, alcohol	TWA = 20 Skin	TWA = 100 Skin	–
108	**1,3-Dioxolane** *646-06-0* *$C_3H_6O_2$* *74.08*	16.8 – 63.4	–	TWA = 20	–	–
109	**Diphenylamine** *122-39-4* *$C_{12}H_{13}N$* *169.22*	0.022 – 0.188	floral	TWA = 1.44	–	–
110	**Dodecyl Mercaptan** *112-55-0* *$C_{12}H_{26}S$* *202.4*	0.00000011 – 0.000097	skunk	TWA = 0.1 SEN	–	–
111	**Epichlorohydrin** *106-89-8* *C_3H_5ClO* *92.53*	0.08 – 12	chloroform	TWA = 0.5 Skin	TWA = 5 Skin	–
112	**Ethane** *74-84-0* *C_2H_6* *30.07*	20,328 – 730,973	–	TWA = 1000	–	–
113	**Ethanolamine** *141-43-5* *C_2H_7NO* *61.08*	2.6 – 24	ammonia	TWA = 3 STEL = 6	TWA = 3	–
114	**2-Ethoxyethanol** *110-80-5* *$C_4H_{10}O_2$* *90.12*	0.3 – 49	sweet, musty	TWA = 5 Skin BEI	TWA = 200 Skin	–
115	**2-(2-Ethoxyethoxy) ethanol** *111-90-0* *$C_6H_{14}O_3$* *134.17*	<0.219 – 1.09	mild, pleasant	–	–	TWA = 25

Table 6.1 – Odor Threshold Values, cont.

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	**Range of Odor Values** (ppm)	**Odor Character**	**ACGIH TLV®** (ppm)	**OSHA PEL** (ppm)	**AIHA WEEL®** (ppm)
116	**2-Ethoxyethyl Acetate** *111-15-9* $C_6H_{12}O_3$ *132.16*	0.048 – 0.13	sweet, ester	TWA = 5 Skin BEI	TWA = 100 Skin	–
117	**Ethyl Acetate** *141-78-6* $C_4H_8O_2$ *88.1*	0.09 – 190	fruity, sweet, fingernail polish, etherous	TWA = 400	TWA = 400	–
118	**Ethyl Acrylate** *140-88-5* $C_5H_8O_2$ *100.11*	0.0000066 – 0.0032	sweet, ester, plastic, alcohol, sharp, ammoniacal	TWA = 5 STEL = 15	TWA = 25 Skin	–
119	**Ethyl Alcohol** *64-17-5* C_2H_6O *46.07*	0.09 – 40334	vinous, alcohol	STEL = 1000	TWA = 1000	–
120	**Ethylamine** *75-04-7* C_2H_7N *45.08*	0.027 – 3.5	ammonia	TWA = 5 STEL = 15 Skin	TWA = 10	–
121	**Ethyl Amyl Ketone** *541-85-5* $C_8H_{16}O$ *128.21*	5.9	solvent, sharp	TWA = 10	TWA = 25	–
122	**Ethyl Benzene** *100-41-4* C_8H_{10} *106.16*	<0.002 – 18	oily, solvent	TWA = 20 STEL = 125 BEI	TWA = 100	–
123	**Ethyl Bromide** *74-96-4* C_2H_5Br *108.97*	2.7 – 3.6	ethereal	TWA = 5 Skin	TWA = 200	–
124	**Ethyl Chloride** *75-00-3* C_2H_5Cl *64.51*	3.8 – 379	pungent	TWA = 100 Skin	TWA = 1000	–
125	**Ethylene** *74-85-1* C_2H_4 *28.05*	17 – 1029	grassy	TWA = 200	–	–
126	**Ethylene Chlorohydrin** *107-07-3* C_2H_5ClO *80.51*	0.36	ethereal	C = 1 Skin	TWA = 5 Skin	–
127	**Ethylenediamine** *107-15-3* $C_2H_8N_2$ *60.1*	1.3 – 4.5	ammonia	TWA = 10 Skin	TWA = 10	–
128	**Ethylene Dibromide** *106-93-4* $C_2H_4Br_2$ *187.86*	<10	sweet	Skin	TWA = 20 C = 30	–

Table 6.1 – Odor Threshold Values, cont.

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	Range of Odor Values (ppm)	Odor Character	ACGIH TLV® (ppm)	OSHA PEL (ppm)	AIHA WEEL® (ppm)
129	**Ethylene Dichloride** *107-06-2* $C_2H_4Cl_2$ *98.96*	4.3 – 988	sweet	TWA = 10	TWA = 50 C = 100	–
130	**Ethylene Glycol** *107-21-1* $C_2H_6O_2$ *62.07*	5.12	–	C = 39 H	–	–
131	**Ethyleneimine** *151-56-4* C_2H_5N *43.07*	0.71 – 2	ammonia	TWA = 0.05 STEL = 0.1 Skin	1910.1003 carcinogen	–
132	**Ethylene Oxide** *75-21-8* C_2H_4O *44.65*	0.82 – 690	sweet, olefinic	TWA = 1	TWA = 1 STEL = 5	–
133	**Ethyl Ether** *60-29-7* $C_4H_{10}O$ *74.12*	0.165 – 1,924	anesthetic, etherous	TWA = 400 STEL = 500	TWA = 400	–
134	**Ethyl Formate** *109-94-4* $C_3H_6O_2$ *74.08*	2.7 – 30	aromatic	STEL = 100	TWA = 100	–
135	**Ethylidene Norbornene** *16219-75-3* C_9H_{12} *120.19*	0.007 – 0.08	turpentine	C = 5	–	–
136	**Ethyl Mercaptan** *75-08-1* C_2H_6S *62.13*	0.0000087 – 18	rotten cabbage	TWA = 0.5	C = 10	–
137	**N-Ethylmorpholine** *100-74-3* $C_6H_{13}NO$ *115.18*	0.085 – 0.25	ammonia	TWA = 5 Skin	TWA = 20 Skin	–
138	**Ethyl Silicate** *78-10-4* $C_8H_{20}SiO_4$ *208.3*	3.6 – 85	sweet, alcohol	TWA = 10	TWA = 100	–
139	**Fluorine** *7782-41-4* F_2 *37.997*	0.097 – 0.19	pungent	TWA = 1 STEL = 2	TWA = 0.1	–
140	**Formaldehyde** *50-00-0* CH_2O *30.03*	0.027 – 9,770	pungent	C = 0.3 SEN	TWA = 0.75 STEL = 2	–
141	**Formic Acid** *64-18-6* CH_2O_2 *46.02*	0.52 – 340	sharp	TWA = 5 STEL = 10	TWA = 5	–

Table 6.1 – Odor Threshold Values, cont.

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	Range of Odor Values (ppm)	Odor Character	ACGIH TLV® (ppm)	OSHA PEL (ppm)	AIHA WEEL® (ppm)
142	**Furan** *110-00-9* C_4H_4O *68.07*	10.06	strong	–	–	(W)
143	**Furfural** *98-01-1* $C_5H_4O_2$ *96.08*	0.002 – 0.713	bread, almond	TWA = 2 Skin BEI	TWA = 5 Skin	–
144	**Furfuryl Alcohol** *98-00-0* $C_5H_6O_2$ *98.1*	8	sweet, ether, alcohol	TWA = 10 STEL = 15 Skin	TWA = 50	–
145	**Glutaraldehyde** *111-30-8* $C_5H_8O_2$ *100.12*	0.00037 – 0.039	–	C = 0.05 SEN	–	–
146	**Halothane** *151-67-7* $C_2HBrClF_3$ *197.4*	33	chloroform	TWA = 50	–	–
147	**Heptane, all isomers** *142-82-5, 590-35-2, 565-59-3 108-08-7, 591-76-4, 589-34-4* C_7H_{16} *100.2*	0.41 – 732	gasoline	TWA = 400 STEL = 500	TWA = 500	–
148	**Hexachlorocyclopentadiene** *77-47-4* C_5Cl_6 *272.77*	0.15	pungent	TWA = 0.01	–	–
149	**1,6-Hexamethylene Diisocyanate** *822-06-0* $C_8H_{12}N_2O_2$ *168.19*	0.005 – 0.01	–	TWA = 0.005	–	–
150	**n-Hexane** *110-54-3* C_6H_{14} *86.17*	1.50 – 248	gasoline	TWA = 50 Skin BEI	TWA = 500	–
151	**Hexane, isomers except n-hexane** *107-83-5, 96-14-0, 75-83-2, 79-29-8* C_6H_{14} *86.17*	0.426 – 20	gasoline	TWA = 500 STEL = 1,000	–	–
152	**1,6-Hexanediamine** *124-09-4* $C_6H_{16}N_2$ *116.2*	0.00067	–	TWA = 0.5	–	TWA = 1
153	**1-Hexene** *592-41-6* C_6H_{12} *84.16*	0.139	petroleum	TWA = 50	–	–

Table 6.1 – Odor Threshold Values, cont.

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	Range of Odor Values (ppm)	Odor Character	ACGIH TLV® (ppm)	OSHA PEL (ppm)	AIHA WEEL® (ppm)
154	**sec-Hexyl Acetate** *108-84-9* $C_8H_{16}O_2$ *144.21*	<0.068 – 0.39	banana, pear, fruity	TWA = 50	TWA = 50	–
155	**n-Hexyl Alcohol** *111-27-3* $C_6H_{14}O$ *102.18*	0.0024 – 16	green grass, plastic	–	–	TWA = 40 Eye irritation
156	**Hexylene glycol** *107-41-5* $C_6H_{14}O_2$ *118.18*	3.93	mild, sweet	C = 25	–	–
157	**Hydrazine** *302-01-2* N_2H_4 *32.05*	3.0 – 4.0	ammonia	TWA = 0.01 Skin	TWA = 1 Skin	–
158	**Hydrogen Chloride** *7647-01-0* HCl *36.47*	0.06 – 10	sharp, irritating	C = 2	C = 5	–
159	**Hydrogen Cyanide** *74-90-8* CHN *27.03*	0.009 – 5.43	almonds	C = 4.7 Skin	TWA = 10 Skin	–
160	**Hydrogen Fluoride** *7664-39-3* HF *20.01*	0.04	highly corrosive, irritating	TWA = 0.5 C = 2 Skin, BEI	TWA = 3	–
161	**Hydrogen Selenide** *7783-07-5* H_2Se *80.98*	<0.3	garlic	TWA = 0.05	TWA = 0.05	–
162	**Hydrogen Sulfide** *7783-06-4* H_2S *34.08*	0.00004 – 1.4	rotten eggs	TWA = 1 STEL = 5	C = 20	–
163	**Indene** *95-13-6* C_9H_8 *116.15*	0.0027 – 0.0042	–	TWA = 5	–	–
164	**Iodine** *7553-56-2* I_2 *253.81*	0.973	sharp, alliaceous	TWA = 0.01 STEL = 0.1 IFV	C = 0.1	–
165	**Iodoform** *75-47-8* CHI_3 *393.78*	0.000019 – 1.12	chemical, etherish	TWA = 0.6	–	–
166	**Isoamyl Acetate** *123-92-2* $C_7H_{14}O_2$ *130.18*	0.00075 – 366	banana, fresh	TWA = 50 STEL = 100	TWA = 100	–

Table 6.1 – Odor Threshold Values, cont.

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	**Range of Odor Values** (ppm)	**Odor Character**	**ACGIH TLV®** (ppm)	**OSHA PEL** (ppm)	**AIHA WEEL®** (ppm)
167	**Isoamyl Alcohol** *123-51-3* *$C_5H_{12}O$* *88.15* *bitter*	0.00169 – 1.75	sweet, malty, rancid, rubber,	TWA = 100 STEL = 125	TWA = 100	–
168	**Isobutyl Acetate** *110-19-0* *$C_6H_{12}O_2$* *116.16*	0.008 – 129	sweet, ester, medicinal	TWA = 150	TWA = 150	–
169	**Isobutyl Alcohol** *78-83-1* *$C_4H_{10}O$* *74.12*	0.01 – 165	sweet, fusel, musty, alcohol, rubber, latex	TWA = 50	TWA = 100	–
170	**Isobutyraldehyde** *78-84-2* *C_4H_8O* *72.11*	0.00034 – 0.139	pungent	–	–	TWA = 25
171	**Isooctyl Alcohol** *26952-21-6, 60435-70-3* *$C_8H_{18}O$* *130.23*	0.0092 – 0.049	faint, pleasant	TWA = 50 Skin	–	–
172	**Isophorone** *78-59-1* *$C_9H_{14}O$* *138.2*	0.0003 – 0.19	sharp	C = 5	TWA = 25	–
173	**Isoprene** *78-79-5* *C_5H_8* *68.12*	0.047 – 3.59	aromatic	–	–	TWA = 2
174	**Isopropyl Acetate** *108-21-4* *$C_5H_{10}O_2$* *102.13*	0.160 – 41	fruity	TWA = 100 STEL = 200	TWA = 250	–
175	**Isopropyl Alcohol** *67-63-0* *C_3H_8O* *60.09*	1.0 – 2,197	sharp, rubbing alcohol	TWA = 100	TWA = 200	–
176	**Isopropylamine** *75-31-0* *C_3H_9N* *59.08*	0.025 – 0.70	ammoniacal, amine	TWA = 5 STEL = 10	TWA = 5	–
177	**Isopropyl Ether** *108-20-3* *$C_6H_{14}O$* *102.17*	0.017 – 0.053	sweet	TWA = 250 STEL = 310	TWA = 500	–
178	**d-Limonene** *138-86-3* *$C_{10}H_{16}$* *136.23*	0.0018 – 0.31	lemon, plastic, citrus, rubber, terpeny	–	–	TWA = 30
179	**Maleic Anhydride** *108-31-6* *$C_4H_2O_3$* *98.06*	0.25 – 0.32	acrid	TWA = 0.0025 IFV, SEN	TWA = 0.25	–

Table 6.1 – Odor Threshold Values, cont.

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	Range of Odor Values (ppm)	Odor Character	ACGIH TLV® (ppm)	OSHA PEL (ppm)	AIHA WEEL® (ppm)
180	**Mercaptoethanol** *60-24-2* C_2H_6OS *78.13*	0.075	–	–	–	TWA = 0.2 Skin
181	**Mesityl Oxide** *141-79-7* $C_6H_{10}O$ *98.14*	0.017 – 12	sweet	TWA = 15 STEL = 25	TWA = 25	–
182	**Methacrylic acid** *79-41-4* $C_4H_6O_2$ *86.09*	0.54 – 2.84	pungent	TWA = 20	–	–
183	**Methacrylonitrile** *126-98-7* C_4H_5N *67.09*	2.95 – 6.9	–	TWA = 1 Skin	–	–
184	**Methane** *74-82-8* CH_4 *16.04*	2,896,197	–	TWA = 1,000	–	–
185	**2-Methoxyethanol** *109-86-4* $C_3H_8O_2$ *76.09* *alcohol*	<0.096 – 90	sweet,	TWA = 0.1 Skin BEI	TWA = 25	–
186	**2•Methoxyethyl Acetate** *110-49-6* $C_5H_{10}O_3$ *118.13*	0.33 – 0.64	sweet, ester	TWA = 0.1 Skin BEI	TWA = 25	–
187	**1-Methyoxy-2-Propanol** *107-98-2* $C_4H_{10}O_2$ *90.12*	8.39 – 33	etherish, ammonia	TWA = 100 STEL = 150	–	–
188	**1-Methoxy-2-Propanol Acetate** *108-65-6* $C_6H_{12}O_3$ *132.16*	0.0029 – 0.13	–	–	–	TWA = 50
189	**Methyl Acetate** *79-20-9* $C_3H_6O_2$ *74.08*	0.17 – 2,848	fruity	TWA = 200 STEL = 250	TWA = 200	–
190	**Methyl Acrylate** *96-33-3* $C_4H_6O_2$ *86.09*	0.003 – 0.025	plastic, sharp, airplane glue	TWA = 2 Skin SEN	TWA = 10 Skin	–
191	**Methyl Alcohol** *67-56-1* CH_4O *32.04*	3.05 – 198,686	sour, sweet, alcohol	TWA = 200 STEL = 250 Skin BEI	TWA = 200	–
192	**Methylamine** *74-89-5* CH_5N *31.06*	0.00075 - 4.8	fishy	TWA = 5 STEL = 15	TWA = 10	-

Table 6.1 – Odor Threshold Values, cont.

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	Range of Odor Values (ppm)	Odor Character	ACGIH TLV® (ppm)	OSHA PEL (ppm)	AIHA WEEL® (ppm)
193	**Methyl n-amyl Ketone** *110-43-0* $C_7H_{14}O$ *114.18*	0.00075 – 0.71	sweet, mushroom	TWA = 50	TWA = 100	–
194	**N-Methyl Aniline** *100-61-8* C_7H_9N *107.15*	1.6 – 2.0	–	TWA = 0.5 Skin BEI	TWA = 2 Skin	–
195	**2-Methyl Butyl Acetate** *624-41-9* $C_7H_{14}O_2$ *130.18*	0.026 – 0.039	–	TWA = 50 STEL = 100	–	–
196	**Methyl tert-Butyl Ether** *1634-04-4* $C_5H_{12}O$ *88.15*	0.03 – 0.17	anesthetic	TWA = 50	–	–
197	**Methyl n-Butyl Ketone** *591-78-6* $C_6H_{12}O$ *100.16*	0.024 – 1.15	sweet, paint	TWA = 5 STEL = 10 Skin BEI	TWA = 100	–
198	**Methyl Chloride** *74-87-3* CH_3Cl *50.49*	>10	sweet, etherish	TWA = 50 STEL = 100	TWA = 100 Skin	–
199	**Methyl Chloroform** *71-55-6* $C_2H_3Cl_3$ *133.42*	0.97 – 715	sweet, etherish	TWA = 350 STEL = 450 BEI	TWA = 350	–
200	**Methyl 2-Cyanoacrylate** *137-05-3* $C_5H_5NO_2$ *111.1*	0.99 – 2.97	–	TWA = 0.2	–	–
201	**Methylcyclohexane** *108-87-2* C_7H_{14} *98.19*	0.149	petroleum	TWA = 400	TWA = 500	–
202	**2-Methylcyclohexanone** *583-60-8* $C_7H_{12}O$ *112.17*	0.181	acetone	TWA = 50 STEL = 75 Skin	TWA = 100 Skin	–
203	**Methylene Bisphenyl Isocyanate** *101-68-8* $C_{15}H_{10}O_2N_2$ *250*	0.39	–	TWA = 0.005	C = 0.02	–
204	**Methylene Chloride** *75-09-2* CH_2Cl_2 *84.94*	1.2 – 440	sweet	TWA = 50 BEI	TWA = 25	–
205	**Methyl Ethyl Ketone** *78-93-3* C_4H_8O *72.1*	0.07 – 339	sweet, sharp	TWA = 200 STEL = 300 BEI	TWA = 200	–

Table 6.1 – Odor Threshold Values, cont.

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	Range of Odor Values (ppm)	Odor Character	ACGIH TLV® (ppm)	OSHA PEL (ppm)	AIHA WEEL® (ppm)
206	**Methyl Formate** *107-31-3* $C_2H_4O_2$ *60.06*	67 – 2,809	ethereal	TWA = 100 STEL = 150	TWA = 100	–
207	**Methyl Hydrazine** *60-34-4* CH_6N_2 *46.07*	1 – 3	ammonia	TWA = 0.01 Skin	C = 0.2 Skin	–
208	**Methyl Isoamyl Ketone** *110-12-3* $C_7H_{11}O$ *114.2*	0.0021 – 0.135	sweet, sharp	TWA = 50	TWA = 100	–
209	**Methyl Isobutyl Ketone** *108-101* $C_6H_{12}O$ *100.16*	0.03 – 16	sweet, sharp	TWA = 20 STEL = 75 BEI	TWA = 100	–
210	**Methyl Isocyanate** *624-83-9* C_2H_3NO *57.05*	2.14	–	TWA = 0.02 Skin	TWA = 0.02 Skin	–
211	**Methyl Isopropyl Ketone** *563-80-4* $C_5H_{10}O$ *86.14*	0.51 – 4.8	sweet, sharp	TWA = 20	–	–
212	**Methyl Mercaptan** *74-93-1* CH_4S *48.11*	0.00000000000051 – 0.56	rotten cabbage, garlic	TWA = 0.5	C = 10	–
213	**Methyl Methacrylate** *80-62-6* $C_5H_8O_2$ *100.13*	0.014 – 0.66	plastic, sharp	TWA = 50 STEL = 100 SEN	TWA = 100	–
214	**2-Methylnaphthalene** *91-57-6* $C_{11}H_{10}$ *142.2*	0.00069	–	TWA = 0.5 Skin	–	–
215	**Methyl Parathion** *298-00-0* $C_8H_{10}NO_5PS$ *263.23*	0.0012	pungent	TWA = 0.002 IFV Skin	–	–
216	**4-Methyl-2-Propanol** *108-11-2* $C_6H_{14}O$ *102.17*	0.335 – 0.526	–	TWA = 25 STEL = 40 Skin	TWA = 25 Skin	–
217	**Methyl Propyl Ketone** *107-87-9* $C_5H_{10}O$ *86.17*	0.028 – 65	fingernail polish	STEL = 150	TWA = 200	–
218	**n-Methyl-2-Pyrrolidone** *872-50-4* C_5H_9NO *99.13*	4.2 – 10	amine	–	–	TWA = 10 Skin

Table 6.1 – Odor Threshold Values, cont.

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	Range of Odor Values (ppm)	Odor Character	ACGIH TLV® (ppm)	OSHA PEL (ppm)	AIHA WEEL® (ppm)
219	**Methyl Styrene** *98-83-9* C_9H_{10} *118.18*	0.02 – 49.7	–	TWA = 10	C= 100	–
220	**Methyl Vinyl Ketone** *78-94-4* C_4H_6O *70.09*	0.174	pungent	C = 0.2 Skin SEN	–	–
221	**Monochloroacetic Acid** *79-11-8* $C_2H_3ClO_2$ *94.5*	0.013 – 0.155	–	TWA = 0.5 IFV Skin	–	TWA = 0.5 Skin
222	**Morpholine** *110-91-8* C_4H_9NO *87.12*	0.011 – 0.070	fishy, amine	TWA = 20 Skin	TWA = 20 Skin	–
223	**Naphthalene** *91-20-3* $C_{10}H_8$ *128.16*	0.0019 – 1.02	tar, creosote, mothballs, empyreumatic	TWA = 10 STEL = 15 Skin	TWA = 10	–
224	**1-Naphthylamine** *134-32-7* $C_{10}H_9N$ *143.19*	0.024 – 0.050	–	–	1910.1003 carcinogen	–
225	**2-Naphthylamine** *91-59-8* $C_{10}H_9N$ *143.19*	0.24 – 0.32	–	–	1910.1003 carcinogen	–
226	**Nickel Carbonyl** *13463-39-3* $Ni(CO)_4$ *170.73*	0.5 – 3	sooty	TWA = 0.05	TWA = 0.001	–
227	**Nicotine** *54-11-5* $C_{10}H_{14}N_2$ *162.23*	0.0099	–	TWA = 0.075 Skin	TWA = 0.075 Skin	–
228	**Nitric Acid** *7697-37-2* HNO_3 *63.02*	0.27	suffocating	TWA = 2 STEL = 4	TWA = 2	–
229	**Nitrobenzene** *98-95-3* $C_6H_5NO_2$ *123.11*	0.0004 – 29	almonds, shoe polish, pungent	TWA = 1 Skin BEI	TWA = 1 Skin	–
230	**Nitrogen Dioxide** *10102-44-0* NO_2 *46.01*	0.058 – 0.5	bleach	TWA = 0.2	C = 5	–
231	**Nitromethane** *75-52-5* CH_3NO_2 *61.04*	50	–	TWA = 20	TWA = 100	–

Table 6.1 – Odor Threshold Values, cont.

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	Range of Odor Values (ppm)	Odor Character	ACGIH TLV® (ppm)	OSHA PEL (ppm)	AIHA WEEL® (ppm)
232	**1-Nitropropane** *108-03-2* $C_3H_7NO_2$ *89.09*	7.7 – 140	–	TWA = 25	TWA = 25	–
233	**2-Nitropropane** *79-46-9* $C_3H_7NO_2$ *89.09*	4.94 – 288	fruity	TWA = 10	TWA = 25	–
234	**N-Nitrosodimethylamine** *62-75-9* $C_2H_6N_2O$ *74.08*	0.0079 – 0.013	faint	Skin, L	1910.1003 carcinogen	–
235	**Nonane** *111-84-2* C_9H_{20} *128.26*	2.3 – 21	gasoline	TWA = 200	–	–
236	**Octane, all isomers** *111-65-9, 540-84-1, 86290-81-5* C_8H_{18} *114.22*	0.66 – 235	gasoline, oil	TWA = 300	TWA = 500 n-Octane only	–
237	**1-Octanol** *111-87-5* $C_8H_{18}O$ *130.23*	0.0009 – 1.69	penetrating	–	–	TWA = 50
238	**1-Octene** *111-66-0* C_8H_{16} *112.21*	0.001 – 206	–	–	–	TWA = 75
239	**Oxygen Difluoride** *7783-41-7* OF_2 *54*	0.0996	strong, peculiar	C = 0.05	TWA = 0.05	–
240	**Ozone** *10028-15-6* O_3 *48*	0.0031 – 0.25	pungent, thunder storm	TWA = 0.05	TWA = 0.1	–
241	**Pentaborane** *19624-22-7* B_5H_9 *63.17*	0.97	pungent	TWA = 0.005 STEL = 0.015	TWA = 0.005	–
242	**Pentane, all isomers** *78-78-4, 109-66-0, 463-82-1* C_5H_{12} *72.15*	1.29 – 1147	sweet	TWA = 600	TWA = 1,000	–
243	**2,4-Pentanedione** *123-54-6* $C_5H_8O_2$ *100.12*	0.0098 – 0.0195	–	TWA = 25 Skin	–	–

Table 6.1 – Odor Threshold Values, cont.

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	Range of Odor Values (ppm)	Odor Character	ACGIH TLV® (ppm)	OSHA PEL (ppm)	AIHA WEEL® (ppm)
244	**Pentanol, all isomers** *71-41-0,75-85-4, 75-84-3, 123-51-3, 137-32-6, 584-02-1, 598-75-4, 6032-29-7, 30899-19-5, 94624-12-1* $C_5H_{12}O$ *88.15*	0.0055 – 305	–	–	–	TWA = 100 71-41-0 only
245	**Perchloroethylene** *127-18-4* C_2Cl_4 *165.84*	0.767 – 71	etherish	TWA = 25 STEL = 100 BEI	TWA = 100 C = 200	–
246	**Perchloryl Fluoride** *7616-94-6* $ClFO$ *70.45*	14.58	sweet	TWA = 3 STEL = 6	TWA = 3	–
247	**Phenol** *108-95-2* C_6H_5OH *94.11*	0.0045 – 1.95	medicinal, acid, ink, creosote, empyreumatic	TWA = 5 Skin BEI	TWA = 5 Skin	–
248	**Phenyl Mercaptan** *108-98-5* C_6H_6S *110.17*	0.00003 – 0.00027	putrid	TWA = 0.1 Skin	–	–
249	**Phosgene** *75-44-5* $COCl_2$ *98.92*	0.12 – 5.7	hay like	TWA = 0.1	TWA = 0.1	–
250	**Phosphine** *7803-51-2* PH_3 *34*	0.01 – 5	garlic	TWA = 0.3 STEL = 1	TWA = 0.3	–
251	**Phthalic Anhydride** *85-44-9* $C_8H_4O_3$ *148.1*	0.053	choking	TWA = 1 SEN	TWA = 2	–
252	**Picolines** *109-06-8, 108-99-6, 108-89-4* C_6H_7N *93.13*	0.0026 – 0.0236	strong, unpleasant	–	–	TWA = 2 STEL = 5 Skin
253	**Piperdine** *110-89-4* $C_5H_{11}N$ *85.15*	0.14 – <2	pepper	–	–	TWA = 1 Skin
254	**Propane** *74-98-6* C_3H_8 *44.09*	1497 – 19964	natural gas	TWA = 1000	TWA = 1000	–
255	**Propionaldehyde** *123-38-6* C_3H_6O *58.08*	0.001 – 101	fruity	TWA = 20	–	TWA = 20

Table 6.1 – Odor Threshold Values, cont.

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	Range of Odor Values (ppm)	Odor Character	ACGIH TLV® (ppm)	OSHA PEL (ppm)	AIHA WEEL® (ppm)
256	**Propionic Acid** *79-09-4* $C_3H_6O_2$ *74.08*	0.00099 – 4.65	sour	TWA = 10	–	–
257	**n-Propyl Acetate** *109-60-4* $C_5H_{10}O_2$ *102.13*	0.048 – 87	sweet, ester	TWA = 200 STEL = 250	TWA = 200	–
258	**Propyl Alcohol** *71-23-8* C_3H_8O *60.09*	<0.031 – 10172	sweet, alcohol	TWA = 100	TWA = 200	–
259	**Propylene** *115-07-1* C_3H_6 *42.08*	10.1 – 99	gassy, aromatic	TWA = 500	–	–
260	**Propylene Dichloride** *78-87-5* $C_3H_6Cl_2$ *112.99*	0.26 – 8.66	sweet	TWA = 10 SEN	TWA = 75	–
261	**Propylene Glycol** *57-55-6* $C_3H_8O_2$ *76.09*	5.14	–	–	–	TWA = 3.2
262	**Propylene Glycol Dinitrate** *6423-43-4* $C_3H_6N_2O_6$ *166.09*	0.236	disagreeable	TWA = 0.05 Skin BEI	–	–
263	**Propylene Oxide** *75-56-9* C_3H_6O *58.08*	10 – 199	sweet	TWA = 2 SEN	TWA = 100	–
264	**Pyridine** *110-86-1* C_5H_5N *79.1*	0.01 – 12	burnt, pungent, nauseating	TWA = 1	TWA = 5	–
265	**Quinoline** *91-22-5* C_9H_7N *129.16*	0.0057 – 5.3	peculiar	–	–	TWA = 0.001 Skin
266	**Quinone** *106-51-4* $C_6H_4O_2$ *108.09*	0.011 – 0.10	pungent	TWA = 0.1	TWA = 0.1	–
267	**Styrene, monomer** *100-42-5* C_8H_8 *104.14*	0.0028 – 61	sharp, sweet	TWA = 20 STEL = 40 BEI	TWA = 100 C = 200	–

Table 6.1 – Odor Threshold Values, cont.

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	**Range of Odor Values** (ppm)	**Odor Character**	**ACGIH TLV®** (ppm)	**OSHA PEL** (ppm)	**AIHA WEEL®** (ppm)
268	**Sulfur Dioxide** *7446-09-5* SO_2 *64.07*	0.33 - 8	metallic	STEL = 0.25	TWA = 5	-
269	**Sulfur Hexafluoride** *2551-62-4* F_6S *146.06*	4,017,527	–	TWA = 1,000	TWA = 1,000	–
270	**Sulfuric Acid** *7664-93-9, 8014-95-7* H_2SO_4 *98.08*	0.15	–	TWA = 0.05	TWA = 0.25	
271	**1,1,2,2-Tetrabromoethane** *79-27-6* $C_2H_2Br_4$ *345.65*	<0.99	camphor, pungent	TWA = 0.1 IFV	TWA = 1	–
272	**1,1,2,2-Tetrachloroethane** *79-34-5* $C_2H_2Cl_4$ *167.9*	0.233 – 7.3	solvent	TWA = 1 Skin	TWA = 5 Skin	–
273	**Tetrahydrofuran** *109-99-9* C_4H_8O *72.1*	0.092 – 61	ether	TWA = 50 STEL = 100 Skin	TWA = 200	–
274	**Thiogylcolic Acid** *68-11-1* $C_2H_4O_2S$ *92.12*	0.00021	unpleasant	TWA = 1 Skin	–	–
275	**Toluene** *108-88-3* C_7H_8 *92.13*	0.021 – 157	sour, burnt	TWA = 20 BEI	TWA = 200 C = 300	–
276	**Toluene 2,4- or 2,6-Diisocyanate** *584-84-9, 91-08-7* $C_9H_6N_2O_2$ *174.06*	0.02 – 2	–	TWA = 0.005 STEL = 0.02 SEN	C = 0.02 584-84-9 only	–
277	**o-Toluidine** *95-53-4* C_7H_9N *107.15*	0.025 – 6.6	aromatic, amine, empyreumatic	TWA = 2 Skin BEI	TWA = 5 Skin	–
278	**m-Toluidine** *108-44-1* C_7H_9N *107.15*	0.46 – 5.9	empyreumatic	TWA = 2 Skin BEI	–	–
279	**p-Toluidine** *106-49-0* C_7H_9N *107.15*	0.027 – 3.2	amine, empyreumatic	TWA = 2 Skin BEI	–	–

Table 6.1 – Odor Threshold Values, cont.

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	Range of Odor Values (ppm)	Odor Character	ACGIH TLV® (ppm)	OSHA PEL (ppm)	AIHA WEEL® (ppm)
280	**Trichloroacetic acid** *76-03-9* $C_2HCl_3O_2$ *163.39*	0.24 – 0.37	–	TWA = 1	–	–
281	**1,2,4-Trichlorobenzene** *120-82-1* $C_6H_3Cl_3$ *181.46*	2.96	aromatic	C = 5	–	–
282	**Trichloroethylene** *79-01-6* C_2HCl_3 *131.4*	0.5 – 167	ether, solvent	TWA = 10 STEL = 25 BEI	TWA = 100 C = 200	–
283	**Trichlorofluoromethane** *75-69-4* CCl_3F *137.37*	5 – 200,057	–	C = 1000	TWA = 1000	–
284	**Triethanolamine** *102-71-6* $C_6H_{15}NO_3$ *149.19*	>10	mild, ammonia	TWA = 0.82	–	–
285	**Triethylamine** *121-44-8* C_3H_9N *101.19*	0.005 – 2.9	fishy, amine	TWA = 1 STEL = 3 Skin	TWA = 25	–
286	**Trimethylamine** *75-50-3* $C_6H_{15}N$ *59.11*	0.00002 – 1.82	fishy, pungent	TWA = 5 STEL = 15	–	TWA = 1
287	**Trimethyl Benzene, all isomers** *95-63-6, 108-67-8, 526-73-8, 25551-13-7* C_9H_{12} *120.19*	0.006 – 2.4	aromatic	TWA = 25	–	–
288	**Trimethyl Phosphite** *121-45-9* $C_3H_9O_3P$ *124.08*	0.000099	pungent	TWA = 2	–	–
289	**Turpentine & monoterpenes** *80-56-8, 127-91-3, 13466-78-9, 8006-64-2* $C_{10}H_{16}$ *136.23*	0.00006 – 19	turpentine, rosiny, pine tree, camphorous, fir needles	TWA = 20 SEN	TWA = 100 80006-64-2 only	–
290	**n-Valeraldehyde** *110-62-3* $C_5H_{10}O$ *86.13*	0.0004 – 4.97	sickening, rancid, decayed	TWA = 50	–	–

Table 6.1 – Odor Threshold Values, cont.

#	**Compound Name** *CAS Number* *Formula* *Molecular Weight*	Range of Odor Values (ppm)	Odor Character	ACGIH TLV® (ppm)	OSHA PEL (ppm)	AIHA WEEL® (ppm)
291	**Vanillin** *121-33-5* $C_8H_8O_3$ *152.15*	0.00000016 – 0.0929	vanilla, caramel, sweet	–	–	TWA = 1.6
292	**Vinyl Acetate** *108-05-4* $C_4H_6O_2$ *86.09*	0.12 – 0.4	sour, sharp	TWA = 10 STEL = 15	–	–
293	**Vinyl Chloride** *75-01-4* C_2H_3Cl *62.5*	203 – 356	sweet	TWA = 1	TWA = 1 STEL = 5	–
294	**Vinylidene chloride** *75-35-4* $C_2H_2Cl_2$ *96.94*	50 – 1387	chloroform	TWA = 5	–	–
295	**Xylene (o-, m-, p-, isomers)** *1330-20-7, 95-47-6* *108-38-3, 106-42-3* C_8H_{10} *106.16*	0.012 – 316	sweet, empyreumatic	TWA = 100 STEL = 150 BEI	TWA = 100	

Table 6.2 – Methods Summary of Reviewed Articles

Threshold methodologies were reviewed according to the criteria discussed in Section 4.4.

The table contains the following information:

- Source (Last name of first author) and publication date
- Panel size
- Panel selection criteria (i.e., trained, screened, etc.)
- Panel calibration
- Vapor modality (usually air; however, in a few cases water vapor or water)
- Diluent (unless specified otherwise in the paper, it was assumed to be air)
- Presentation mode (type of instrument at interface)
- Analytic measure
- Flow rate
- Threshold type
- Concentration series
- Trials (greater than one trial)
- Forced choice
- Concentration interval (less than or equal to a three-fold step size)

Abbreviations Used in Table

- R = recognition
- D = detection
- MP = minimum perceptible
- I = intensity
- A = ascending
- D = descending
- R = random
- V = variable
- U-D = up-down series
- ng – information not given in article
- nd – data not determined, usually in a foreign language article
- VDD8 = Vapor Delivery Device

Table 6.2 – Methods Summary of Reviewed Articles

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	Size	Selection Criteria	Calibration	Vapor Modality	Diluent	Presentation Mode	Analytic Measure	Flow Rate	Threshold Type	Conc. Series	Trials	Forced - Choice	Conc. Interval	Note #
Adams (1968)	114 - 789	no	no	air	pure air	odor hood	yes	2-5 lpm	D	A + D + R	yes	no	yes	
Ahlstrom (1986a)	40	yes	yes	air	air	odor hood	yes	100 lpm	D	A + D + R	yes	yes	yes	
Ahlstrom (1968b)	64	yes	no	air	air	mobile olfactometer	yes	100 lpm	D	A	yes	yes	yes	
Akhemedov (1968)	4	yes	no	air	carbon filtered	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Alibaev (1970)	25	yes	no	air	carbon filtered	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Allison (1919)	ng	ng	ng	air	pure air	glass	no	≥8 lpm	D	ng	ng	no	ng	1
Amdur (1953)	14	ng	ng	air	air	face mask	yes	ng	R	ng	ng	no	yes	1
Amoore (1978)	>10	ng	ng	water	water or buffered water	flask	no	static	D	D	ng	yes	yes	56
Amoore (1977)	>10	ng	ng	water	water or buffered water	flask	no	static	D	D	ng	yes	yes	20, 56
Andreescheva (1964)	29	yes	yes	air	carbon filtered	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Andreescheva (1968)	26	yes	no	air	carbon filtered	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Appell (1969)	ng	ng	ng	water	water	bottle	ng	static	MP	ng	ng	ng	yes	17
Babin (1965)	ng	ng	ng	air	ng	ng	ng	ng	ng	ng	ng	ng	ng	2

Table 6.2 – Methods Summary of Reviewed Articles, cont.

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	Size	Selection Criteria	Calibration	Vapor Modality	Diluent	Presentation Mode	Analytic Measure	Flow Rate	Threshold Type	Conc. Series	Trials	Forced - Choice	Conc. Interval	Note #
Baikov (1963)	nd	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	46
Baikov (1973)	28	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	46
Basmadzhieva (1968)	13	ng	ng	air	ng	ng	ng	0.2-0.6 lpm	MP	ng	yes	yes	yes	36
Baydar (1993)	79	yes	no	air	air	olfactometer	yes	ng	D + R	A	yes	yes	yes	12
Belkov (1969)	ng	ng	ng	air	ng	ng	ng	ng	ng	ng	ng	ng	ng	2
Berglund (1992)	44	yes	no	air	natrium hydroxide	dynamic olfactometer	yes	100 lpm	D	A	yes	yes	yes	52
Berzins (1967)	18	ng	ng	air	ng	ng	ng	ng	ng	ng	ng	ng	ng	2
Bezpalkova (1967a)	23	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	yes	45
Blank (1993)	7	yes	ng	air	nitrogen	GC-olfactometry	yes	0.01 lpm	D	ng	yes	ng	ng	50
Blank (1989)	ng	ng	ng	ng	ng	GC-olfactometry	ng	ng	D	ng	ng	ng	ng	
Blinova (1965)	9 - 10	ng	ng	air	ng	gas mask	ng	ng	MP	ng	yes	ng	ng	46
Bocca (1964)	3	ng	ng	air	ng	blast	ng	167 lpm	D	D	yes	ng	ng	20, 62
Bokowa (2012)	3	yes	ng	ng	ng	dynamic olfactometer	ng	ng	D	ng	ng	ng	ng	

Table 6.2 – Methods Summary of Reviewed Articles, cont.

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	Size	Selection Criteria	Calibration	Vapor Modality	Diluent	Presentation Mode	Analytic Measure	Flow Rate	Threshold Type	Conc. Series	Trials	Forced - Choice	Conc. Interval	Note #
Boriskova (1957)	12	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	46
Brunekreef (1980)	4	ng	ng	air	air	ng	ng	ng	ng	ng	ng	yes	ng	59
Buettner (2001a)	10	yes	yes	air	water	bottle	ng	static	D	ng	yes	ng	ng	
Buettner (2001b)	ng	ng	ng	ng	ng	ng	ng	ng	D	ng	ng	ng	ng	
Bushtueva (1962)	ng	yes	ng	air	Clean air	cylinder	ng	ng	ng	ng	ng	no	ng	1
Buttery (1969)	>10	ng	ng	water	water	bottles	no	static	D + R	D	ng	yes	yes	20, 56
Cain (1987)	57, 72	yes	yes	air	propane, argon	olfactometer, bottles	yes	static, 180 lpm, 85 lpm	D + R	A	yes	yes	yes	51
Cain (2005)	33	yes	ng	air	silicon oil, water	glass vessel	yes	static, 3 lpm	D, S, I (eye)	A	yes	yes	yes	49
Cain (2007a)	10	yes	ng	air	air	VDD8	yes	40 lpm	D	yes	yes	yes	yes	
Cain (2008)	48	yes	ng	air	mineral oil, water	squeeze bottles	yes	static	D	A	yes	yes	yes	
Cain (2009)	29, 26	yes	no	air	nitrogen, air	VDD8	yes	78 lpm, 10 lpm	D + I (eye)	A	yes	yes	yes	49
Cain (1969)	12	ng	ng	vapor	Diethylphthalate	test tubes	no	static	R	A + D	yes	no	yes	19
Cain (1977)	2	ng	no	air	water	glass vessel	yes	static	D	A + D	yes	yes	ng	25

Table 6.2 – Methods Summary of Reviewed Articles, cont.

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	**Size**	**Selection Criteria**	**Calibration**	**Vapor Modality**	**Diluent**	**Presentation Mode**	**Analytic Measure**	**Flow Rate**	**Threshold Type**	**Conc. Series**	**Trials**	**Forced - Choice**	**Conc. Interval**	**Note #**
Cain (2007b)	50	yes	ng	air	air	VDD8	yes	40 lpm	D	yes	yes	yes	yes	
Cain (2010)	70, 17	yes	yes	air	nitrogen	VDD8	yes	1 lpm	D + eye irritation	ng	ng	ng	ng	49
Cancho (2001)	5 - 6	yes	ng	air	methanol or MTBE	Flavor Profile or GC-O	yes	ng	D	ng	ng	ng	ng	55
Catana (2012)	248	no	no	ng	ng	sniffin sticks	ng	ng	R	ng	ng	ng	ng	
Cederlof (1966)	30	ng	ng	air	air	hood	ng	100 lpm	D	A	ng	yes	yes	
Cerny (1994)	3	yes	ng	ng	ng	GC-olfactometery	ng	ng	D	ng	ng	ng	ng	
Chao-Chen-Tzi (1959)	13	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	46
Cheesman (1959)	10-20	ng	ng	air	air	tube	no	yes	D	V	5	no	yes	29, 57
Clausen (1955)	ng	ng	ng	air	pure air	tube	ng	stream	D	D	ng	yes	ng	1, 20
Cometto-Muniz (1990)	7	yes	ng	air	mineral oil	squeeze bottles	yes	static	D	A	yes	yes	yes	
Cometto-Muniz (1991)	4	yes	no	air	mineral oil	squeeze bottles	yes	static	D, I	A	yes	yes	yes	
Cometto-Muniz (1993)	8	yes	ng	air	water, mineral oil	squeeze bottles	yes	static	D	A	yes	yes	yes	49
Cometto-Muniz (2002)	8	yes	ng	air	mineral oil	squeeze bottles	yes	static	D	A	yes	yes	yes	

Table 6.2 – Methods Summary of Reviewed Articles, cont.

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	**Size**	**Selection Criteria**	**Calibration**	**Vapor Modality**	**Diluent**	**Presentation Mode**	**Analytic Measure**	**Flow Rate**	**Threshold Type**	**Conc. Series**	**Trials**	**Forced - Choice**	**Conc. Interval**	**Note #**
Cometto-Muniz (2008)	34	yes	yes	air	air	VDD8	yes	40 lpm	D	A	yes	yes	yes	44
Cometto-Muniz (2008)	36	yes	yes	air	air	VDD8	yes	40 lpm	D	A	yes	yes	yes	44
Cometto-Muniz (2009a)	39	yes	yes	air	air	VDD8	yes	40 lpm	D	A	yes	yes	yes	44
Cometto-Muniz (2009b)	36	yes	yes	air	air	VDD8	yes	40 lpm	D	A	yes	yes	yes	44
Cometto-Muniz (2010a)	16	yes	yes	air	air	VDD8	yes	40 lpm	D	A	yes	yes	yes	41
Cometto-Muniz (2010b)	14	yes	yes	air	air	VDD8	yes	40 lpm	D	A	yes	yes	yes	41
Cometto-Muniz (1998a)	11	yes	ng	air	mineral oil	squeeze bottles	yes	static	D	A	yes	yes	yes	
Cometto-Muniz (1998b)	4	yes	yes	air	mineral oil	squeeze bottles	yes	static	D	A	yes	yes	yes	49
Cometto-Muniz (2003)	varied	yes	ng	air	ng	glass bottles	yes	static	D	A	yes	yes	yes	
Cometto-Muniz (2004)	10	yes	ng	?	mineral oil	bottle	yes	static	D, S, I (eye)	yes	yes	yes	yes	
Cometto-Muniz (2005)	varied	yes	ng	air	mineral oil	glass bottles	yes	static	D	A	yes	yes	yes	
Cometto-Muniz (1999)	4, 14	yes	yes	air	mineral oil	squeeze bottles	yes	static	D	A	yes	yes	yes	49
Corbit (1971)	3	yes	no	air	air	nose port	no	2 lpm	D	A	5	yes	yes	37

Table 6.2 – Methods Summary of Reviewed Articles, cont.

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	**Size**	**Selection Criteria**	**Calibration**	**Vapor Modality**	**Diluent**	**Presentation Mode**	**Analytic Measure**	**Flow Rate**	**Threshold Type**	**Conc. Series**	**Trials**	**Forced - Choice**	**Conc. Interval**	**Note #**
Cormack (1974)	4-6	yes	ng	air	air	Room	yes	static	D	ng	ng	no	yes	
Crawford (1984)	4	ng	ng	ng	ng	Triangle Olfactometer	ng	ng	D	A	yes	yes	ng	
Czerny (2008)	ng	ng	ng	ng	water	ng	ng	ng	D	ng	ng	ng	ng	
Czerny (2011)	13	yes	no	air	water	GC-olfactometry	yes	ng	D	D	yes	no	no	
Dalton (1997b)	90	yes	no	air	propylene glycol, mineral oil	squeeze bottles	yes	static	D + I	A	yes	yes	yes	
Dalton (2000)	40	yes	yes	air	air	bottle	yes	static	D, I	U-D	yes	yes	yes	
Dalton (2007)	15	yes	yes	air	air	VDD8	yes	40 lpm	D	A & D	no	yes	yes	47
Davis (1973)	3	ng	ng	air	Clean air	funnel	ng	20 lpm	D	D	ng	no	yes	37
Dixon (1977)	II	yes	ng	air	Oxygen	tube	yes	7-8 lpm	D	U-D	ng	yes	yes	38
Dobrinskii (1964)	ng	ng	ng	air	ng	ng	yes	ng	MP	ng	ng	ng	ng	46
Doty (1984)	1955	ng	ng	ng	ng	ng	ng	ng	D	ng	ng	ng	ng	51
Doty (1988)	36	yes	ng	air	Clean air	bottles	yes	static	D	A + D	ng	yes	yes	
Dravnieks (1971)	5-7	ng	ng	air	ng	ng	yes	ng	D	ng	ng	ng	ng	

Table 6.2 – Methods Summary of Reviewed Articles, cont.

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	Size	Selection Criteria	Calibration	Vapor Modality	Diluent	Presentation Mode	Analytic Measure	Flow Rate	Threshold Type	Conc. Series	Trials	Forced - Choice	Conc. Interval	Note #
Dravnieks (1972)	nd	nd	nd	water	nd	nd	nd	static	D	nd	nd	nd	nd	
Dravnieks (1968)	ng	ng	ng	air	ng	ng	yes	ng	ng	ng	ng	ng	ng	
Dravnieks (1973)	9	Yes	ng	Air	Pure air	glass port	No	0.6 Lpm	D	A	ng	Yes	Yes	
Dravnieks (1974)	9	ng	ng	Air	Pure air	glass port	No	0.15 Lpm	D	A	ng	Yes	Yes	
Duan-Fen-Djuy (1959)	12	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	46
Dubrovskaya (1961)	12	ng	ng	air	ng	ng	ng	ng	MP	ng	yes	ng	yes	46
Dubrovskaya (1973)	18	yes	ng	air	carbon filtered	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Dubrovskaya (1957)	12	ng	ng	air	ng	ng	ng	ng	MP	ng	yes	ng	yes	36
Dubrovskaya (1969)	22	yes	ng	air	carbon filtered	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Dumas (1974)	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	
Eglite (1968)	20	yes	ng	air	carbon filtered	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Elfimova (1967	18	ng	ng	air	ng	ng	ng	ng	ng	ng	yes	ng	ng	2
Feddes (2001)	24	yes	yes	air	air	olfactometer	Indirectly	Up to 20 lpm	D	A	yes	yes	ng	8

Table 6.2 – Methods Summary of Reviewed Articles, cont.

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	Size	Selection Criteria	Calibration	Vapor Modality	Diluent	Presentation Mode	Analytic Measure	Flow Rate	Threshold Type	Conc. Series	Trials	Forced - Choice	Conc. Interval	Note #
Feldman (1960)	nd	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	45
Feldman (1971)	15	yes	ng	air	ng	ng	yes	ng	MP	ng	ng	ng	yes	46
Feldman (1967)	20	yes	ng	air	carbon filtered	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Ferreira (1998)	4	yes	ng	air	helium	GC-olfactometry	yes	4 ml/min	D	ng	ng	ng	ng	33
Filatova (1962)	14	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	46
Fischer (2008)	2	no	yes	air	Dichloromethane	nasal cone	yes	ng	D	D	no	no	ng	13
Flemming (1977)	18 - 20	yes	ng	air	Compressed air	tube	yes	10 lpm	R	A	no	no	yes	
Fluck (1976)	10	ng	ng	air	Room air	test room	yes	static	R	R	ng	no	yes	4
Fomin (1966)	18	ng	ng	air	ng	ng	ng	ng	MP	ng	ng	ng	ng	
Gijs (2000)	3	yes	ng	air	air	GC-olfactometery	yes	20 ml/min	D	yes	no	no	no	
Glindemann (2006)	4	yes	ng	air	ng	dilution olfactometer	yes	ng	D	D	ng	ng	ng	
Gofmekler (1967)	nd	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	
Gofmekler (1960)	nd	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	46

Table 6.2 – Methods Summary of Reviewed Articles, cont.

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	Size	Selection Criteria	Calibration	Vapor Modality	Diluent	Presentation Mode	Analytic Measure	Flow Rate	Threshold Type	Conc. Series	Trials	Forced - Choice	Conc. Interval	Note #
Gorlova (1970)	24	ng	ng	air	ng	ng	yes	ng	MP	ng	yes	ng	ng	
Greenman (2004)	7	yes	yes	air	several	bottles	no	0.2 lpm	D	ng	yes	ng	yes	14
Grigorieva (1964)	12	yes	ng	air	carbon filtered	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Gundlach (1939)	16-60	ng	ng	air	pure air	nose piece	no	0.041-0.35 lpm	D	ng	ng	yes	yes	24
Gusev (1965)	18-30	yes	ng	air	carbon filtered	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Guth (2001)	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	13
Hartung (1971)	ng	ng	ng	air	ng	ng	yes	ng	ng	ng	ng	ng	ng	5
Hellman (1974)	5	yes	no	air	air	air stream	yes	20-80 lpm	D+R	A	yes	yes	yes	
Hellman (1973a,b)	5	yes	no	air	air	air stream	yes	20-80 lpm	D+R	A	yes	yes	yes	
Hesse (1926)	ng	ng	ng	air	ng	ng	ng	ng	ng	ng	ng	ng	ng	1
Hesse (1928)	ng	ng	ng	air	ng	ng	yes	ng	ng	ng	ng	ng	ng	1
Higuchi (2004)	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	
Hildenskiold (1959)	nd	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	45

Table 6.2 – Methods Summary of Reviewed Articles, cont.

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	Size	Selection Criteria	Calibration	Vapor Modality	Diluent	Presentation Mode	Analytic Measure	Flow Rate	Threshold Type	Conc. Series	Trials	Forced - Choice	Conc. Interval	Note #
Hollingsworth (1963)	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	
Holmes (1915)	60	no	ng	air	air	booth	ng	High Velocity	D+R	A	yes	no	yes	
Homans (1978)	16	nd	nd	air	nd	nd	yes	yes	D	A	nd	nd	yes	29
Hori (1972)	5 - 10	no	ng	air	air	syringe	yes	static	ng	A	ng	no	ng	1
Hoshika (1997)	7	ng	ng	air	air	ng	yes	static	R	two	ng	ng	ng	53
Ifeadi (1972)	1	no	ng	air	Charcoal filtered	hood	yes	0.4 lpm	D	A	yes	no	yes	37
Imasheva (1963)	18	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	46
Itskovich (1962)	ng	ng	ng	air	ng	ng	ng	ng	ng	ng	ng	ng	ng	2
Ivanov (1964)	11	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	46
Jacobson (1955)	15 - 22	ng	ng	air	Room air	nostril piece	yes	static	D	A	ng	no	yes	
Jacobson (1956)	14 - 16	ng	ng	air	Room air	nostril piece	yes	static	D	A	ng	no	yes	
Jacobson (1958)	13	ng	ng	air	Room air	nostril piece	yes	static	D	A	ng	no	yes	
Jones (1954)	4	no	no	air	pure air	nostril piece	no	3 lpm	R	A	yes	no	ng	1, 46

Table 6.2 – Methods Summary of Reviewed Articles, cont.

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	Size	Selection Criteria	Calibration	Vapor Modality	Diluent	Presentation Mode	Analytic Measure	Flow Rate	Threshold Type	Conc. Series	Trials	Forced - Choice	Conc. Interval	Note #
Jones (1955a)	24	no	no	water	Mineral Spirits	flask	no	static	ng	A	yes	no	ng	1
Jones (1955b)	45	no	no	air	pure air	nostril piece	no	3 lpm	R	A	no	no	ng	1
Jones (1955c)	84	no	no	air	pure air	nostril piece	no	3 lpm	D	A	no	no	ng	1
Kaloyanova (1967)	10	yes	no	air	ng	ng	ng	ng	MP	ng	ng	ng	yes	
Kaloyanova (1968)	12	yes	ng	air	carbon filtered	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Katz (1930)	7 - 14	no	no	air	pure air	funnel	no	≥8 lpm	D	A	no	no	yes	
Kerka (1956)	6	yes	ng	air	nitrogen	test room	ng	static	D + R	ng	yes	no	ng	21
Khachaturyan (1968)	3	ng	ng	air	ng	ng	ng	ng	ng	D	yes	ng	yes	38
Khachaturyan (1969)	3	ng	ng	air	ng	ng	ng	ng	ng	ng	yes	ng	ng	36
Khiari (1992)	ng	yes	ng	ng	ng	GC-olfactometery	yes	ng	D	ng	ng	ng	ng	
Khikmatullaeva (1967)	21	yes	ng	air	ng	ng	ng	ng	MP	ng	ng	ng	ng	
Kinkead (1971a)	6	no	no	air	Test room	no	no	static	D	R	yes	no	yes	3
Kinkead (1971b)	3	no	no	air	Test room	no	no	static	D	ng	yes	no	2-5	37

Table 6.2 – Methods Summary of Reviewed Articles, cont.

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	**Size**	**Selection Criteria**	**Calibration**	**Vapor Modality**	**Diluent**	**Presentation Mode**	**Analytic Measure**	**Flow Rate**	**Threshold Type**	**Conc. Series**	**Trials**	**Forced - Choice**	**Conc. Interval**	**Note #**
Kleinbeck (2011)	44	yes	no	air	nitrogen	flow olfactometer	yes	ng	D + I	A	yes	yes	yes	
Kniebes (1969)	13 - 33	no	ng	air	nitrogen	test room		static	D	R	yes	no	yes	20
Komthong (2006)	3	yes	ng	air	air	GC-olfactometery	yes	ng	D	D	only two trials	no	ng	34
Korneev (1965)	22	yes	ng	air	carbon	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Kosiborod (1968)	22	yes	ng	air	carbon filtered	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Krackow (1953)	ng	ng	ng	air	ng	ng	ng	ng	D	ng	ng	ng	ng	
Krasovitskaya (1968)	11	yes	ng	air	Clean air	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Krichevskaya (1968)	21	yes	ng	air	Clean air	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Kristesashvili (1965)	12	ng	ng	air	ng	ng	ng	ng	MP	ng	ng	ng	ng	
Kulakov (1964)	19	yes	ng	air	Clean air	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Laffort (1987)	9	yes	ng	ng	ng	tedlar bags	ng	ng	D	ng	ng	ng	ng	32
Laffort (1973)	4	no	no	air	air	Mono rhinal valve	yes	0.4 lpm	D	R	yes	ng	ng	1, 20, 37
Laing (1975)	6	no	no	air	nitrogen	sniff port	yes	0.04 lpm	D	R + D	yes	no	yes	38

Table 6.2 – Methods Summary of Reviewed Articles, cont.

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	Size	Selection Criteria	Calibration	Vapor Modality	Diluent	Presentation Mode	Analytic Measure	Flow Rate	Threshold Type	Conc. Series	Trials	Forced - Choice	Conc. Interval	Note #
Laing (1978)	16	yes	no	air	nitrogen	nose & mouth port	yes	10 lpm	R	R	yes	no	yes	42
Laing (1982)	23	yes	yes	air	air	chamber & olfactometer	ng	10 lpm	D	A–D	yes	yes	yes	
Laska (2010)	20	yes	no	air	several	squeeze bottles	no	static	D	A	yes	yes	yes	10
Laska (1991)	44	yes	ng	air	n-butanol	sniff bottles	estimated	static	D	A	yes	yes	ng	31
Leonardos (1969)	4	yes	no	air	Purified air	test room	no	static	100% R	R	no	no	no	
L-Shen (1961)	15	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	46
Loginova (1957)	11	ng	ng	air	air	bifarate tube		ng	MP	ng	yes	no	yes	36
Lotsch (1997)	5	yes	yes	air	air	dynamic olfactometer	yes	ng	D, I	A–D	yes	yes	yes	
Makhinya (1966)	19	yes	ng	air	carbon filtered	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Malyarova (1967)	ng	ng	ng	air	ng	ng	ng	ng	ng	ng	ng	ng	ng	2
Marin (1988)	8	yes	yes	air	air	G-olfactometry	yes	ng	D	D	yes	no	ng	54
Martirosyan (1970)	ng	ng	ng	air	ng	ng	ng	ng	ng	ng	ng	ng	ng	2
Mateson (1955)	ng	yes	yes	air	ng	glass funnel	ng	yes	ng	ng	ng	ng	ng	8, 29

Table 6.2 – Methods Summary of Reviewed Articles, cont.

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	Size	Selection Criteria	Calibration	Vapor Modality	Diluent	Presentation Mode	Analytic Measure	Flow Rate	Threshold Type	Conc. Series	Trials	Forced - Choice	Conc. Interval	Note #
May (1966)	16	yes	ng	air	air	flask	yes	static	D+R	U-D	yes	no	yes	60
McGinley (2003)	5	yes	no	air	air	Scentometer, Nasal Ranger	yes	16 - 20 lpm	D	A	yes	yes	yes	8
Melekhina (1958)	nd	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	46
Melekhina (1968)	16	yes	ng	air	carbon filtered	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Melzner (2011)	25	yes	yes	air	air	olfactometer	yes	8 lpm	D	A	yes	yes	yes	9
Minaev (1966)	19	yes	ng	air	carbon filtered	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Miryakubova (1970)	ng	ng	ng	air	ng	ng	ng	ng	MP	ng	ng	ng	ng	2
Miyazawa (2009a)	12	yes	ng	air	water	GC-olfactometry	yes	30 lpm	D	A	yes	yes	yes	31
Mnatsakanyan (1962)	11	yes	ng	air	ng	ng	yes	ng	R	ng	yes	ng	yes	1
Molhave (2000)	12	yes	yes	Aor	air	olfactometer	ng	ng	D	A	no	yes	yes	18
Moskowitz (1974)	33	no	ng	air	air	nose port	yes	0.12 lpm	D	ng	ng	no	yes	40
Muhlen (1968)	4	ng	ng	air	air	hood	yes	static	R	U-D	ng	no	yes	37
Mukhamedova (1968)	22	yes	ng	air	carbon filtered	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36

Table 6.2 – Methods Summary of Reviewed Articles, cont.

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	Size	Selection Criteria	Calibration	Vapor Modality	Diluent	Presentation Mode	Analytic Measure	Flow Rate	Threshold Type	Conc. Series	Trials	Forced - Choice	Conc. Interval	Note #
Mukhitov (1971)	ng	ng	ng	air	ng	ng	ng	ng	ng	ng	ng	ng	ng	2
Mukhitov (1962)	14	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	46
Mullins (1955)	9 - 23	no	no	air	air	nose port	no	4 lpm	R	ng	yes	no	ng	37
Murphy (1985)	9 - 20	yes	ng	air	air	dilution olfactometer	no	no	D	A + D	ng	yes	yes	63
Nader (1958)	10	no	no	air	pure air	mask	no	15-20 lpm	D	A	yes	no	yes	
Nagata (2003)	6	yes	yes	air	nitrogen	tedlar bag	yes	static	D	ng	ng	yes	ng	
Neuhaus (1957)	nd	nd	nd	air	nd	nd	nd	nd	D + R	nd	nd	nd	no	28
Nevers (1965)	6+	ng	ng	air	pure air	funnel	ng	1.25 lpm	I	R	ng	yes	yes	58
Nikiforov (1970)	ng	ng	ng	air	ng	ng	ng	ng	ng	ng	ng	ng	ng	2
Nimmermark (2011)	4 - 16	yes	yes	ng	ng	olfactometer	ng	ng	D + R	ng	yes	yes	yes	
Nishida (1975)	20	ng	ng	air	Fresh air	mask	ng	1 lpm	D	ng	ng	no	yes	
Nishida (1979)	8 - 11	ng	ng	air	carbon	mask	yes	2 lpm	D	A + D	yes	no	yes	19
Nordin (1997)	16	yes	yes	air	air	dynamic olfactometer	yes	100 lpm	D	yes	yes	yes	yes	39

Table 6.2 – Methods Summary of Reviewed Articles, cont.

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	Size	Selection Criteria	Calibration	Vapor Modality	Diluent	Presentation Mode	Analytic Measure	Flow Rate	Threshold Type	Conc. Series	Trials	Forced - Choice	Conc. Interval	Note #
Novikov (1957)	12	yes	ng	air	ng	ng	ng	ng	MP	ng	yes	ng	yes	36
Odoshashvili (1962)	12	yes	ng	air	carbon filtered	cylinder	yes	15 lpm	MP	nd	yes	yes	yes	36
Olsson (2010)	500	yes	no	air	Diethyl Phthalate	squeeze bottles	no	static	D	A	yes	yes	yes	12
Ozturk (1976)	12-26	yes	ng	water vapor	Distilled water	aerosol bottle	yes	static	D	A	ng	no	yes	
Pangborn (1964)	5	yes	ng	air	pure air	hood	no	ng	D	R	yes	yes	yes	
Parker (1913)	2	ng	ng	air	air	jar	no	static	R	ng	yes	yes	yes	37
Patterson (1993)	40	yes	ng	air	mineral oil	squeeze bottles	yes	static	D	A + D	yes	yes	no	
Piggott (1975)	10	yes	ng	water	water	bottle	no	static	ng	R	yes	no	yes	20
Pliska (1965)	nd	nd	nd	air	nd	nose port	nd	nd	nd	ng	A	nd	nd	
Plotnikova (1957)	nd	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	46
Pogosyan (1965)	18	ng	ng	air	ng	ng	ng	ng	MP	ng	ng	ng	ng	
Polednik (2008)	22	yes	ng	air	air	Room	yes	ng	D	ng	yes	yes	yes	
Polgar (1975)	6	yes	ng	air	pure air	cup	ng	3 lpm	R	A	ng	yes	yes	

Table 6.2 – Methods Summary of Reviewed Articles, cont.

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	**Size**	**Selection Criteria**	**Calibration**	**Vapor Modality**	**Diluent**	**Presentation Mode**	**Analytic Measure**	**Flow Rate**	**Threshold Type**	**Conc. Series**	**Trials**	**Forced - Choice**	**Conc. Interval**	**Note #**
Poostchi (1986)	7 to 10	ng	ng	ng	ng	olfactometer	yes	0.1 lpm	D-R	ng	yes	yes	yes	
Popov (1970)	ng	ng	ng	air	ng	ng	ng	ng	MP	ng	ng	ng	ng	
Pozzani (1968)	8 - 9	no	ng	air	air	test room	yes	static	D	R	yes	no	yes	3
Prusakov (1976)	7	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	46
Punter (1983)	26 - 44	nd	nd	air	nitrogen	port	yes	5 lpm	D	A	yes	yes	yes	
Randebrock (1971)	5	ng	ng	air	ng	sniff port	yes	ng	ng	ng	1-5	ng	ng	1
Ripp (1968)	16	yes	ng	air	pure air	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Rylova (1953)	ng	ng	ng	air	ng	ng	ng	ng	ng	ng	ng	ng	ng	1
Sadilova (1968)	17	yes	ng	air	carbon filtered	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Saifutdinov (1966)	22	yes	ng	air	carbon filtered	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Sanders (1970)	4	yes	yes	air	Clean air	mask	no	12 lpm	D	A	yes	no	yes	37
Savenhed (1985)	ng	ng	ng	air	ng	G-olfactometery	yes	ng	D	ng	ng	ng	ng	
Scherberger (1958)	3	no	no	air	air	glass	yes	07 or 3.1 lpm	R	ng	yes	no	ng	1, 37

Table 6.2 – Methods Summary of Reviewed Articles, cont.

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	**Size**	**Selection Criteria**	**Calibration**	**Vapor Modality**	**Diluent**	**Presentation Mode**	**Analytic Measure**	**Flow Rate**	**Threshold Type**	**Conc. Series**	**Trials**	**Forced - Choice**	**Conc. Interval**	**Note #**
Scherberger (1960)	ng	ng	ng	ng	ng	ng	ng	ng	D	ng	ng	ng	ng	
Schmidt (2010)	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	16
Schneider (1955)	53	yes	ng	air	Odor free air	test room	no	static	D	R + D + A	yes	no	ng	20
Schneider (1966)	8	yes	ng	air	nitrogen	nares piece	yes	0.6-4.8 lpm	R	A	yes	no	ng	1
Schulman (2011)	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	61
Selyuzhitskii (1976)	ng	ng	ng	air	ng	ng	ng	ng	ng	ng	ng	ng	ng	2
Sgibnev (1968)	nd	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	46
Shalamberidze (1967)	14-15	ng	ng	air	ng	ng	ng	ng	MP	ng	ng	ng	ng	
Shusterman (1997a)	30	yes	no	air	air	nasal canula	no	5 lpm	I (Irritation)	A	no	no	no	49
Sinkuvene (1970)	ng	ng	ng	air	ng	ng	ng	ng	MP	ng	ng	ng	ng	
Slavgorodskiy (1968)	27	ng	ng	air	ng	ng	ng	ng	MP	ng	yes	ng	yes	
Slotnick (1984)	10	ng	ng	ng	air	olfactometer	ng	ng	ng	ng	ng	ng	ng	
Smeets (2002)	26	yes	yes	air	propylene glycol, mineral oil	bottle	Y	static	D and I	A + D	yes	yes	yes	47

Table 6.2 – Methods Summary of Reviewed Articles, cont.

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	Size	Selection Criteria	Calibration	Vapor Modality	Diluent	Presentation Mode	Analytic Measure	Flow Rate	Threshold Type	Conc. Series	Trials	Forced - Choice	Conc. Interval	Note #
Smeets (2007)	24	yes	yes	air	water	bottle	yes	static & Dynamic	D and I	A	yes	yes	yes	49
Smith (1969)	7	ng	ng	air	nitrogen	nose piece	yes	static	R	D	ng	yes	yes	20
Solomin (1961)	nd	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	46
Solomin (1964)	14	yes	ng	air	carbon	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Stalker (1963)	23	yes	no	air	pure air	mask	yes	15-20 lpm	D	A	yes	no	yes	
Steinmetz (1969)	5	yes	ng	air	Odor free air	hood	no	yes	D	R	yes	yes	ng	20, 29
Stephens (1971)	ng	ng	ng	air	pure air	sniff port	yes	yes	ng	ng	ng	yes	ng	1, 29
Stevens (1993)	24	yes	no	air	water	squeeze bottles	yes	static	D	A	yes	yes	yes	63
Stevens (1988)	3	no	yes	ng	water, mineral oil	squeeze bottles	yes	ng	D	A	ng	yes	yes	
Stewart (1974)	9	yes	ng	air	Room air	test room	yes	static	D	R	yes	no	yes	38
Stone (1965)	9	yes	ng	air	Charcoal filtered	hood	yes	yes	D	R	yes	yes	yes	20, 29
Stone (1967b)	6	yes	ng	air	Odor free air	hood	no	yes	D	R	yes	yes	yes	20, 29
Stone (1962)	48	yes	ng	air	Charcoal filtered	hood	yes	yes	D	R	yes	yes	yes	20, 29

Table 6.2 – Methods Summary of Reviewed Articles, cont.

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	Size	Selection Criteria	Calibration	Vapor Modality	Diluent	Presentation Mode	Analytic Measure	Flow Rate	Threshold Type	Conc. Series	Trials	Forced - Choice	Conc. Interval	Note #
Stone (19623b)	54	no	ng	air	pure air	hood	yes	yes	D	R	yes	yes	yes	20, 29
Stone (1963a)	6	no	ng	air	Charcoal filtered	hood	no	yes	D	R	yes	yes	yes	20, 29
Stone (1967a)	9	yes	ng	air	Charcoal filtered	hood	no	yes	D + R	R	yes	yes	yes	20, 29
Stone (1972)	3 - 5	yes	no	air	air	nose port	yes	yes	D	R	ng	yes	yes	20, 29
Strube (2012)	10	yes	yes	air	air and water	GC-olfactometry	yes	ng	D	ng	ng	ng	ng	
Styazhkin (1973)	17	yes	ng	air	pure air	ng	ng	ng	MP	ng	ng	yes	yes	
Tabakova (1969)	23	yes	ng	air	ng	ng	ng	ng	MP	ng	ng	ng	yes	
Takhiroff (1957)	nd	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	45
Takhirov (1969)	ng	yes	ng	air	carbon filtered	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Tamman (1928)	3-7	ng	ng	air	air	nd	no	yes	D	A	ng	no	yes	29, 37
Tarkhova (1965)	20	yes	ng	air	air	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Tepikina (1968)	24	yes	ng	air	carbon filtered	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Teranishi (1974)	ng	ng	ng	water	water	ng	ng	static	ng	ng	ng	ng	ng	1

Table 6.2 – Methods Summary of Reviewed Articles, cont.

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	Size	Selection Criteria	Calibration	Vapor Modality	Diluent	Presentation Mode	Analytic Measure	Flow Rate	Threshold Type	Conc. Series	Trials	Forced - Choice	Conc. Interval	Note #
Thiele (1979)	3, 15, 150	nd	nd	air	Activated carbon	port	nd	nd	D	nd	nd	yes	yes	
Thriel (2006a)	144	yes	yes	air	water or Mineral Oil	bottle	yes	static	D	A	yes	yes	yes	51
Tkach (1965)	16	yes	ng	air	carbon filtered	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Tkachev (1963)	17	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	46
Tkachev (1969)	ng	ng	ng	air	ng	ng	ng	ng	ng	ng	ng	ng	ng	1
Tkachev (1970)	21	ng	ng	air	ng	ng	ng	ng	ng	ng	ng	ng	ng	
Torkelson (1977)	10	no	no	ng	ng	ng	ng	ng	R	A	ng	ng	yes	
Tsukatani (2003)	31	ng	ng	ng	several	ng	ng	ng	D	A	ng	ng	ng	
Turk (1973)	ng	no	no	air	ambient air	vent	yes	Varied	R	D	yes	no	yes	20
Ubaidullaev (1978)	nd	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	46
Ubaidullaev (1961)	nd	nd	nd	air	nd	nd	nd	nd	MP	nd	nd	nd	nd	46
Ubaidullaev (1966)	25	ng	ng	air	air	ng	yes	ng	MP	ng	ng	ng	ng	
Ueno (2009)	6, 12, 51	yes	yes	ng	air	olfactometer	yes	ng	D	D + A	ng	Triangle Bag Method	yes	

Table 6.2 – Methods Summary of Reviewed Articles, cont.

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	Size	Selection Criteria	Calibration	Vapor Modality	Diluent	Presentation Mode	Analytic Measure	Flow Rate	Threshold Type	Conc. Series	Trials	Forced - Choice	Conc. Interval	Note #
Ventura (1997)	5	ng	ng	air	water, air	GC / Sniffer	yes	71 cm/s	R	A	ng	ng	yes	
Vermeulen (2006)	2	ng	ng	air	air	GC-olfactometry	yes	20ml/min	D	A	ng	ng	yes	
Viswanathan (1983)	17	no	no	ng	ng	bag and olfactometry	ng	static and dynamic	D	A	ng	yes	yes	
Walker (1996)	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	ng	
Walker (2003)	7 & 5	yes	yes	air	air	olfactometer	yes	43 lpm	D	A	Y	no	yes	
Weeks (1960)	12	ng	ng	ng	air	Fair Wells Osmoscope	ng	ng	R	ng	ng	no	ng	
Whisman (1978)	6	yes	ng	air	air	test room	yes	yes	D	A	yes	no	yes	29
Wilby (1964)	3-4	yes	ng	air	air	10-inch square port	no	2830 lpm	D	A	yes	no	yes	37
Wilby (1969)	35	no	ng	air	air	10-inch square port	yes	2830 lpm	R	R	yes	no	yes	42
Williams (1977)	10	yes	nd	air	Clean air	nose port	no	0.5 lpm	D	A	ng	yes	yes	
Winneke (1979)	31	nd	nd	air	nd	hood	yes	yes	D	A	nd	no	yes	29
Wise (2007)	20	yes	yes	nitrogen	air	olfactometer	yes	30 lpm	R	A	yes	yes	yes	
Witheridge (1939)	2	yes	ng	air	Clean air	test room	yes	static	D	ng	ng	no	yes	37

Table 6.2 – Methods Summary of Reviewed Articles, cont.

	Panel			Presentation Apparatus					Presentation Method					
Source (Year)	Size	Selection Criteria	Calibration	Vapor Modality	Diluent	Presentation Mode	Analytic Measure	Flow Rate	Threshold Type	Conc. Series	Trials	Forced - Choice	Conc. Interval	Note #
Yang (2008)	3	ng	ng	ng	hexane	GC-olfactometry	yes	2 ml/min	D	ng	ng	no	yes	
Young (1966)	81	yes	ng	air	Filtered air	mask	yes	57 lpm	D	A	yes	no	yes	
Yuldashev (1965)	20	ng	ng	air	ng	ng	yes	ng	MP	ng	ng	ng	ng	
Zarzo (2012)	ng	ng	ng	ng	ng	ng	ng	ng	D	ng	ng	ng	ng	
Zibireva (1967)	ng	ng	ng	air	pure air	cylinder	yes	15 lpm	MP	ng	yes	yes	yes	36
Ziemer (2000)	10	ng	ng	air	air	Devlin olfactometer	yes	ng	D	A	yes	no	ng	

Notes to Table 6.2

1 A project note about an experimental paper presenting threshold values.

2 Abstract with insufficient information.

3 Adaptation effects were avoided with a 45-min interval between concentrations.

4 Although a random presentation was used in this study, adaptation effects were avoided by presenting stimuli with 30 minute intervals between concentrations.

5 Approximate thresholds determined and no threshold methodology is given.

6 Article only provided the range of all measurements and the values detected 90% of the time.

7 Article investigated an additive effect of odorants.

8 Article focused upon validating olfactometer(s).

9 Article investigated whether subjects detected CO_2 in the nose or the mouth first.

10 Article investigates the odor detection, descrimination and chemesthetic properties.

11 Article investigating nasal irritation sensitivity variation in humans.

12 Article investigating odor threshold differences between males, females, osmics and anosmics.

13 Article contains good descriptions for the compounds found in orange peel vapor.

14 Article investigating the compounds and their organoleptic intensity scales.

15 Article mentions new olfactometer. Flow rate difficult to determine.

16 Article on good odor measurement methods/studies and the vapor delivery device 8 (VDD8).

17 Article refers to a minimal perceptible concentration based on an intensity scale.

18 Article refers to a previously published articles for the details of the odor testing. Results are for brief, 2 minute duration, exposures only.

19 Ascending/descending patterns with consideration of other factors of the experimental design.

20 Concentration series are presented with insufficient time for de-adaptation of the olfactory receptors.

21 Concentration series not given, however the 1-hr waiting period used would eliminate adaptation effects.

22 Concentrations are presented in ascending, descending, and random order.

23 Detection threshold was a 50% response.

24 Different subjects were tested at different concentrations to eliminate adaptation effects.

25 Evaluation of the repeatability of odor threshold data; determining the precision of odor threshold identification methods. air-dilution olfactometer had good precision (4.2%).

26 Experimental purpose was to avoid inhibition.

27 Eye irritation and pugency was measured.

28 German article. A tenfold concentration step size was used.

29 Flow rate difficult to determine.

30 Panel was 50% anosmic.

31 Investigation of how the detection threshold might change when compounds are presented in mixtures.

32 Investigation of olfactory properties of chemicals under hyperbaric atmospheres.

33 Investigation of the properties affecting odor thresholds in hydroalcoholic solutions (like wine).

34 Investigation to identify and quantify the odorants from apple.

35 Investigation to identify the odorants and thresholds from linden tree honey from Romania.

36 The MP is the minimum perceptible concentration of the most sensitive subject.

37 Number of subjects was insufficient to represent the range of olfactory sensitivity.

38 Only one concentration per day was tested to avoid adaptation effects.

39 Only the detection threshold for the Controls (without Alzheimers disease) were quoted.

40 Panelists completed four scaling tasks in 30 min with 10-sec waiting period between sniffs.

41 Participant count is the lowest number of subjects per compound.

42 Random presentation order to determine recognition threshold.

43 Reported values are for 100 percent recognition.

44 Results displayed on small graph in log ppb units; conversion errors may have resulted during conversion.

45 Russian article minimal perceptible value was determined from English summary.

46 Russian article was categorized based on translation of key words and review of tables presenting minimum perceptible values.

47 Study focus was testing olfactory fatigue between exposed and non-exposed workers.

48 Study investigated the odor threshold differences between smokers and non-smokers.

49 Study of the odor and chemesthesis (pungency and eye irritation).

50 Study of the odorant extracts of Lovage using GC-O.

51 Study on possible odorants for inert gas and investigated differences in age, sex, and smoking.

52 Study to compare the odor detection thresholds for smokers and non-smokers.

53 Study to determine the odor recognition thresholds of several organics.

54 Study to identify the odor detection thresholds of common food odorants.

55 Study to identify the odor thresholds of chemicals in drinking water.

56 The study presents air values based on transformed data from water values and a descending series without adequate de-adaptation time.

57 Variable presentation was used with intervals between sniffs to reduce adaptation effects.

58 Threshold was calculated from the intensity slope at the intercept.

59 Thresholds were conducted as training for a field program. Threshold measurement recorded to document panel calibration.

60 Up-down technique used is less likely to cause olfactory fatigue than a descending or random pattern.

61 U.S. EPA Report on odor detection of methyl tert-butyl ether in water based upon on previously published data.

62 Purpose of the experiment was to prove hypothesis on the effects of humidity and temperature on odor thresholds.

63 Investigation of the relationship between odor detection thresholds and age.

64 Study of glutaraldehyde odor detection threshold, eye and throat sensation threshold, and response over time.

65 Only dilution to threshold values presented.

66 Study evaluated subjects ability to recognize the odorant, not to determine a threshold.

67 Study to evaluate the effect of the molecule length (carbon atoms) on the odor detection threshold.

68 Study comparing age-related loss of detection threshold, intensity, pleasantness and repeated exposure effects.

69 Using the triangle odor bag method, 12 years of data on 223 compounds was summaried and trends were examined.

70 Study of individual’s odor detection and hedonic tone from animal production facility odorants.

71 An evaluation of the methodology and data analysis to identify the appropriate study size and trials.

Table 6.3 – Reported Odor Thresholds from All Sources

All published odor threshold values for the 295 chemicals with occupational exposure values.

The table provides the following information:

- Chemical Name
- Source (Last name of first author) and publication date
- Type of odor threshold values reported as either detection (d) or recognition (r)
- All threshold values from the Gemert compendium in both mg/m^3 and ppm.

Note: *Conversion of units from mg/m3 to ppm was based on the molecular weight of the compound and the known volume of a perfect gas or vapor at standard temperature and pressure (STP).*

Table 6.3 – Odor Threshold Values *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
1	**Acetaldehyde**	Zwaardemaker 1914	d	0.7	0.39
		Backman 1917	r	0.062 - 0.075	0.034 - 0.042
		Katz & Talbert 1930	d	0.12	0.067
		Balavoine 1943		10	6
		Pliska & Janicek 1965		1,800	1,000
		Gofmekler 1967, 1968	d	0.012	0.0067
		Leonardos et al 1969	r	0.38	0.21
		Hartung et al 1971		0.005	0.0028
		Takhirov 1974		0.49	0.27
		Teranishi et al 1974		0.041	0.023
		Anon. 1980	d	0.0027	**0.0015**
		Anon. 1980	r	0.027	0.015
		Naus 1982	d	1	0.555
		Naus 1982	r	10	6
		Nagy 1991	d	0.09	0.05
		Nagata 2003	d	0.0027	0.0015
2	**Acetic Acid**	Passy 1893b, 1893c	d	5 - 10	2.0 - 4.1
		Grijns 1906		49 - 76	20 - 31
		Backman 1917	r	4.8 - 5.0	2.0 - 20
		Grijns 1919		2	0.81
		Mitsumoto 1926	r	0.074 - 0.57	0.030 - 0.23
		Hesse 1926	r	0.6	0.24
		Henning 1927	d	3.6	1.5
		Morimura 1934	r	1.82 - 1.91	0.74 - 0.78
		Jung 1936	d	0.025	0.01
		Jung 1936	r	0.05	0.02
		Balavoine 1943, 1948		300 - 500	122 - 204
		Stone 1963c	d	3.9	1.6
		Stone & Bosley 1965	d	4.2	1.7
		Endo et al 1967		6.5	2.65
		Takhirov 1969, 1974		0.6	0.24
		Leonardos et al 1969	r	2.5	1
		Homans et al 1978	d	0.37	0.15
		Naus 1982	d	0.5	0.20
		Naus 1982	r	25	10
		Punter 1983	d	0.09	0.037
		Homans 1984		0.93	0.38
		Walker et al 1990		5	2.04
		Nagy 1991	d	0.37	0.15
		Blank & Schieberle 1993		0.03 - 0.09	0.012 - 0.037
		Walker et al 1996		0.25 - 2.5	0.1 - 1.0
		Cometto - Muniz et al 1998a	d	0.025	0.01
		Cometto - Muniz 1999	d	0.025	0.01

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
2	**Acetic Acid cont.**	Nagata 2003	d	0.015	0.006
		Van Thriel et al 2006	d	1.45	0.59
		Wise et al 2007	d	0.017 - 0.020	0.0069 - 0.0081
		Miyazawa et al 2009a	d	0.017 - 0.020	0.0069 - 0.0081
		Miyazawa et al 2009b	d	0.001	**0.0004**
		Cain et al 2010	d	0.15	0.06
		Cometto - Muniz & Abraham 2010b	d	0.013	0.0053
3	**Acetic Anhydride**	Takhirov 1969		0.49	**0.12**
		Hellman & Small 1973a,b, 1974	d	<0.6	<0.14
		Hellman & Small 1973a,b, 1974	r	1.5	0.36
4	**Acetone**	Zwaardemaker 1914, 1927	d	4 - 7	1.7 - 2.9
		Backman 1917	r	4.1 - 4.3	1.7 - 1.8
		Van Anrooij 1931	d	1.1	0.46
		Jung 1936	d	78	33
		Jung 1936	r	78	33
		Scherberger et al 1958	r	1,900	800
		Stuiver 1958	d	5.8	2.4
		Feldman 1960		1.1	0.46
		Naus 1962	d	4	1.7
		Pogosyan 1965		1.1	0.46
		Tkach 1965		1.1	0.46
		May 1966	d	770	324
		May 1966	r	1,660	699
		Kittel 1968		11 - 240	4.6 - 101
		Leonardos et al 1969	r	240	101
		Kittel & Wendelstein 1971	d	75	32
		Kittel & Wendelstein 1971	r	121	51
		Hartung et al 1971		2.3	0.97
		Dravnieks & Laffort 1972		240	10
		Artho & Koch 1973		1,000 - 10,000	421 - 4,208
		Hellman & Small 1973a,b, 1974	d	48	20
		Hellman & Small 1973a,b, 1974	r	78	33
		Dravnieks 1974	d	1,550	653
		Takhirov 1974		1.15	0.48
		Makeicheva 1978		0.94	**0.4**
		Anon. 1980	d	72	30
		Anon. 1980	r	264	111
		Naus 1982	d	1	0.42
		Naus 1982	r	20	8

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
4	**Acetone cont.**	Punter 1983	d	8.6	3.6
		Nagy 1991	d	40	17
		Cometto - Muniz & Cain 1993	d	27,900	11,745
		Cometto - Muniz 1993	d	27,900	11,745
		Dalton et al 1997a	d	199 - 204	84 - 86
		Dalton et al 1997b	d	626 - 936	263 - 394
		Wysocki et al 1997	d	97 - 2,026	41 - 853
		Dalton et al 2000	d	59	25
		Nagata 2003	d	101	43
		Cometto - Muniz & Abraham 2009a	d	2	0.84
5	**Acetonitrile**	Pozzani et al 1959		<67	<40
		Dravnieks & Laffort 1972		285	170
		Dravnieks 1974	d	1,950	1,161
		Nagata 2003	d	22	**13**
6	**Acetophenone**	Imasheva 1963		0.01	0.002
		Tkach 1965		0.01	0.002
		Korneev 1965		0.01	0.002
		Gavaudan & Poussel 1966		0.23	0.047
		Hellman & Small 1973a,b, 1974		1.5	0.305
		Hellman & Small 1973a,b, 1974	r	2.9	0.59
		Savenhed et al 1985	d	0.01 - 0.04	0.002 - 0.008
		Randebrock 1986		0.0012	**0.00024**
7	**Acetylene**	Deadman & Prigg 1959	d	240	**226**
		Babin et al 1965		1,300 - 2,750	1,222 - 2,584
		Nagy 1991	d	510	479
8	**Acrolein**	Katz & Talbert 1930	d	4.1	1.8
		Plotnikova 1957		0.8	0.35
		Buchberg et al 1961		0.2 - 0.7	0.087 - 0.31
		Leonardos et al 1969	r	0.48	0.21
		Sinkuvene 1970		0.07	0.031
		Knuth 1973		0.14	0.061
		Cormack et al 1974		0.23	0.1
		Teranishi et al 1974		0.05	0.022
		Anon. 1980	d	0.069	0.03
		Anon. 1980	r	0.32	0.14
		Nagata 2003	d	0.0083	**0.0036**
9	**Acrylic Acid**	Hellman & Small 1974	d	0.27	**0.092**
		Hellman & Small 1974	r	3	1
		Piringer & Granzer 1984		2	0.679
		Van Thriel et al 2006	d	1.5	0.51

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
10	**Acrylonitrile**	Stalker 1963	d	3.4	**1.6**
		Leonardos et al 1969	r	47	22
		Nagata 2003	d	19	8.8
11	**Allyl Alcohol**	Katz & Talbert 1930	d	3.3	1.4
		Jones 1955c	d	83	35
		Dunlap et al 1958		1.9	0.8
		Pliska & Janicek 1965		48	20
		Dravnieks 1974	d	5	2.1
		Dravnieks & Laffort 1972		1.2	**0.51**
12	**Allyl Chloride**	Toxicity Data Sheet 1958a		9.3 - 18.6	3.0 - 5.9
		Torkelson et al 1959		3 - 9	0.958 - 2.875
		Leonardos et al 1969	r	1.5	**0.48**
13	**Allyl Isothiocyanate**	Allison & Katz 1919		8	1.97
		Katz & Talbert 1930		0.61	0.15
		Stone et al 1967a	d	0.19	0.05
		Stone & Pryor 1967b	d	0.037 - 0.24	**0.0091** - 0.0592
14	**Ammonia**	Valentin 1848, 1850		21	30
		Grijns 1906		21.6 - 42	31.0 - 60.3
		Fieldner et al 1921		37	53
		Smolczyk & Cobler 1930		0.71 - 7.1	1.02 - 10.2
		Geier 1936	d	1.25	1.79
		Geier 1936	r	2.5	3.6
		Carpenter et al 1948		0.7	1
		Smyth 1956	r	≤0.7	≤1.00
		Patty 1962a		<3.5	<5.0
		Saifutdinov 1966		0.50 - 0.55	0.72 - 0.79
		Endo et al 1967		37	53
		Leonardos et al 1969	r	33	47
		Hamanabe et al 1969		0.03	**0.043**
		Stephens 1971		2.7	3.9
		Nishida et al 1975	d	1.8 - 37.8	2.6 - 54.3
		Hill & Barth 1976		21	30
		Schoedder 1977		5.0 - 7.6	7.2 - 10.9
		Logtenberg 1978	d	5.2	7.5
		Nishida et al 1979	d	11.6	16.7
		Anon. 1980	d	0.1	0.14
		Anon. 1980	r	0.4	0.57
		Naus 1982	d	1.5	2.15
		Naus 1982	r	35	50
		Nagy 1991	d	3.7	5.31
		Nagata 2003	d	1.1	1.58
		Van Thriel et al 2006	d	0.04	0.057
		Smeets et al 2007	d	1.8	2.58
		Smeets et al 2007	d	1.8	2.58

Table 6.3 – Odor Threshold Values, cont.

Bold = Lowest Value Reported

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
15	**n - Amyl Acetate**	Grijns 1919		0.9	0.17
		Allison & Katz 1919		39	7.3
		Jones 1955c	d	1.6	0.3
		Gofmekler 1960		0.6	0.11
		Pliska & Janicek 1960		31	5.8
		Guadagni 1966		0.05	0.0094
		Davis 1973	d	0.04	0.0075
		Hendriks 1979	d	0.27	0.051
		Slotnick 1981		1.3	0.24
		Laing 1982	d	0.95	0.178
		Punter 1983	d	0.27 - 0.28	0.051 - 0.053
		Cristoph 1983	r	0.045 - 0.06	0.00845 - 0.0113
		Walker et al 1990		6.9	1.3
		Cometto - Muniz & Cain 1991		6.3	1.18
		Cometto - Muniz 1993	d	6.3	1.18
		Walker et al 1996		0.53 - 5.3	0.09954 - 0.9954
		Hoshika et al 1997	r	41	7.7
		Ziemer et al 2000	d	0.049	0.0092
		Walker et al 2003		0.038 - 0.89	**0.007** - 0.167
		Komthong et al 2006		10.7 - 230	2.0 - 43
		Olsson & Laska 2010	d	2.2 - 2.7	0.414 - 0.508
16	**Aniline**	Tempelaar 1913	d	0.97	0.25
		Huijer 1924	d	0.046	**0.012**
		Zwaardemaker 1927	d	0.046	0.012
		Backman 1917	r	5.0 - 5.8	1.3 - 1.5
		Geier 1936	d	1.2 - 1.5	0.32 - 0.39
		Geier 1936		2.0 - 2.5	0.53 - 0.66
		Jacobson et al 1958	d	38	10
		Tkachev 1963		0.37	0.097
		Leonardos et al 1969	r	3.8	1
		Ozturk 1976	d	2.21	0.58
		Naus 1982	d	2	0.53
		Naus 1982	r	20	5.3
17	**Arsine**	Patty 1962b		<3.2	<1.0
18	**Benzaldehyde**	Backman 1917	r	0.33 - 0.50	0.05 - 0.076
		Rocen 1920	r	1.7	0.260
		Ohma 1922	d	0.44	0.067
		Katz & Talbert 1930		0.18	0.027
		Jones 1955c	r	4.1	0.626
		Pliska & Janicek 1965		13	2.0
		Knuth 1973		0.27	0.041
		Laing 1975	d	4.3	0.657
		Nishida et al 1979	d	3,400	783

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
18	**Benzaldehyde cont.**	Randebrock 1986		0.014	0.0021
		Stevens & Cain 1987a	d	0.43 - 43	0.0657 - 6.57
		Khiari et al 1992	d	<0.01	**<0.0015**
		Von Ranson & Belitz 1992b	d	0.61	0.093
		Von Ranson & Belitz 1992b	r	2.1	0.32
		McGee et al 1995	d	0.1 - 1	0.015 - 0.15
		Yang et al 2008		0.085	0.013
19	**Benzene**	Backman 1917	r	6.6 - 6.9	2.1 - 2.2
		Backman 1918		5 - 5.3	1.7
		Zwaardemaker 1927		5 - 5.3	1.7
		Grijns 1919		420	131
		Zwaardemaker 1927		420	131
		Schley 1934	d	8.8	2.8
		Schley 1934	r	12	3.8
		Jones 1954	r	480 - 510	150 - 160
		Jones 1955c	d	180	56
		Novikov 1957		4.9	1.5
		Deadman & Prigg 1959	d	9	2.8
		Gusev 1965		2.8 - 4	0.88 - 1.3
		Naus 1962	d	6	1.9
		May 1966	d	180	56
		May 1966	r	310	97
		Elfimova 1966		2.5	0.78
		Schutte & Zubek 1967	r	310	97
		Leonardos et al 1969	r	15	4.7
		Alibaev 1970		2.9	0.91
		Dravnieks & O'Donnell 1971		38	12
		Koster 1971	d	37	12
		Dravnieks & Laffort 1972		32.5	10.2
		Laffort & Dravineks 1973		14.5	4.5
		Artho & Koch 1973		100 - 1,000	31.3 - 313
		Dravnieks 1974	d	380	119
		Naus 1982	d	1.5	**0.47**
		Naus 1982	r	16	5
		Punter 1983	d	108	34
		Nagata 2003	d	8.6	2.69
20	**Benzoyl Chloride**	Schley 1934	d	0.012 - 0.024	**0.0021** - 0.0042
		Schley 1934	r	0.012 - 0.036	0.0021 - 0.0063
21	**Benzyl Acetate**	Appell 1969		0.001	**0.00016**
		Koster 1971		85 - 135	14 - 22
22	**Benzyl Chloride**	Katz & Talbert 1930	d	0.21	**0.041**
		Leonardos et al 1969	r	0.24	0.046

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
23	**Biphenyl**	Solomin 1961		0.06	0.0095
		Nagy 1991	d	0.0033	**0.00052**
24	**Boron Trifluoride**	Torkelson et al 1961		4.2	1.5
25	**Bromine**	Valentin 1848, 1850		3	0.46
		Henning 1924	d	0.2	0.031
		Rupp & Henschler 1967	d	<0.065	**<0.0099**
		Rupp & Henschler 1967	r	>6.5	>0.99
		Leonardos et al 1969	r	0.3	0.046
		Randebrock 1986		0.9	0.14
26	**Bromoform**	Passy 1893a	d	2 - 5	**0.19** - 0.48
		Backman 1917	r	2.2 - 2.5	0.21 - 0.24
		Grijns 1919		150	15
		Rocen 1920	r	30	2.9
27	**1,3 - Butadiene**	Mullins 1955	r	169	76
		Deadman & Prigg 1959	d	2.1	0.95
		Ripp 1968		4	1.8
		Laffort & Dravnieks 1973		5.8	2.6
		Hellman & Small 1974	d	1	0.45
		Hellman & Small 1974	r	2.4	1.1
		Jeltes 1975		0.22	**0.099**
		Nagata 2003	d	0.51	0.23
28	**Butane, all isomers**	Patty & Yant 1929		12,000	5,048
		Mullins 1955	r	6,160	2,591
		Mullins 1955	r	1,370	576
		Schneider et al 1966		8,700	3,660
		Laffort & Dravnieks 1973		3,000	1,262
		Artho & Koch 1973		1 - 10	**0.421** - 4.21
		Nagata 2003	d	2,880	1,212
29	**Butenes, all isomers**	Katz & Talbert 1930		2.1	0.915
		Katz & Talbert 1930		4.8	2.09
		Katz & Talbert 1930		3	1.31
		Mullins 1955	r	39.2	17
		Mullins 1955	r	2,700	1,177
		Mullins 1955	r	28.5	12
		Mullins 1955	r	4,880	2126
		Krasovitskaya & Malyarova 1968		15.4	6.71
		Knuth 1973		1.2	0.523
		Anon 1980	d	15	6.5
		Anon 1980	r	46	20
		Nagata 2003	d	0.83	**0.362**
		Nagata 2003	d	23	10

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
30	**2 - Butoxyethanol**	Hellman & Small 1973a,b; 1974	d	0.5	0.1
		Hellman & Small 1973a,b; 1974	r	1.7	0.35
		Nagy 1991		0.4	**0.08**
		Nagata 2003		1.3	0.27
31	**2 - Butoxyethyl Acetate**	Hellman & Small 1973a,b; 1974	d	0.7	**0.107**
		Hellman & Small 1973a,b; 1974	r	1.3	0.198
		Nagy 1991	d	6.5	0.99
32	**n - Butyl Acetate**	Backman 1917	r	1.3 - 1.7	0.27 - 0.36
		Jung 1936	d	0.044	0.0093
		Jung 1936	r	0.044 - 0.13	0.0093 - 0.027
		Scherberger et al 1958	r	96	20
		Gofmekler 1960		0.6	0.13
		Pliska & Janicek 1960		190	40
		Naus 1962	d	0.7	0.147
		May 1966	d	35	7.4
		May 1966	r	55	12
		Koster 1971	d	480 - 1,750	101 - 368
		Dravnieks & Laffort 1972		0.04	0.008
		Dravnieks 1974	d	3	0.63
		Hellman & Small 1974	d	0.03	0.0063
		Hellman & Small 1974	r	0.18	0.038
		Anon. 1980	d	0.32	0.067
		Anon. 1980	r	2.4	0.505
		Cristoph 1983	r	0.46 - 0.55	0.097 - 0.116
		Scharfenberger 1990		4	0.84
		Cometto - Muniz & Cain 1991, 1993	d	11.5	2.4
		Cometto - Muniz 1993	d	11.5	2.4
		Nagy 1991	d	1	0.21
		Nagy 1991	d	0.521	0.11
		Patterson et al 1993	d	7.7	1.6
		Ziemer et al 2000	d	0.061	0.013
		Cometto - Muniz et al 2002		0.00062	**0.00013**
		Cometto - Muniz et al 2003		0.009	0.0019
		Nagata 2003	d	0.077	0.016
		Cometto - Muniz et al 2004	d	0.015	0.003
		Komthong et al 2006		165 - 1,570	35 - 330
		Cometto - Muniz et al 2008	d	0.02	0.004
		Cain & Schmidt 2009	d	0.01	0.002

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
33	**sec - Butyl Acetate**	Cometto - Muniz & Cain 1993	d	22.6	4.76
		Cometto - Muniz 1993	d	22.6	4.76
		Nagata 2003	d	0.012	**0.0025**
34	**tert - Butyl Acetate**	Cometto - Muniz & Cain 1993	d	6.2	1.31
		Cometto - Muniz 1993	d	6.2	1.31
		Nagata 2003	d	0.34	0.072
		Cain & Schmidt 2009	d	0.038	**0.008**
35	**Butyl Acrylate**	Anon. 1969		0.53	0.1
		Gemert 1973	d	0.005 - 0.01	0.00096 - 0.0019
		Anon. 1980	d	0.0015	**0.00029**
		Anon. 1980		0.014	0.0027
		Piringer & Granzer		0.01	0.0019
		Nagata 2003	d	0.0029	0.00055
36	**n - Butyl Alcohol**	Passy 1892c	d	1	0.33
		Backman 1917	r	0.35 - 0.6	0.12 - 0.20
		Zwaardemaker 1927		1	0.33
		Jung 1936	d	0.158 - 0.316	0.052 - 0.10
		Jung 1936	r	0.474 - 0.632	0.16 - 0.21
		Gavaudan et al 1948		0.15	0.049
		Mullins 1955	r	37.2	12
		Jones 1955a	r	3.1	1
		Jones 1955b	r	110 - 285	36 - 94
		Jones 1955c	d	42	14
		Scherberger et al 1958	r	45	15
		Janicek et al 1960		20	6.6
		Naus 1962	d	4	1.3
		Pliska & Janicek 1965		3,000	990
		Gavaudan & Poussel 1966		1.1	0.36
		May 1966	d	33	11
		May 1966	r	48	16
		Dravnieks & Krotoszynski 1968		1.35	0.45
		Khachaturyan & Baikov 1969		1.2 - 2	0.7 - 4
		Cain 1969	r	60	20
		Corbit & Engen 1971		13 - 20	4.3 - 6.6
		Dravnieks & Laffort 1972		10	3.3
		Baikov & Khachaturyan 1973		1.2	0.396
		Laffort & Dravnieks 1973		0.9	0.3
		Hellman & Small 1974	d	0.9	0.3
		Hellman & Small 1974	r	3	1
		Moskowitz et al 1974		186	61
		Jones et al 1975		<132	<44
		Piggott & Harper 1975		4 - 1,000	1.3 - 330

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
36	**n - Butyl Alcohol cont.**	Dravnieks 1976	d	0.36 - 10.2	0.12 - 3.4
		Williams et al 1977	d	0.63 - 1.14	0.21 - 0.38
		Amoore & Buttery 1978	d	2.3	0.76
		Homans et al 1978	d	13.94	4.6
		Jones et al 1978	d	42 - 105	14 - 35
		Laing et al 1978	r	10.5	3.5
		Laing 1982	d	3	1
		Cain et al 1983	d	<4.2	<1.4
		Cain et al 1983	d	<4.2	<1.4
		Cristoph 1983	r	0.7 - 0.9	0.23 - 0.30
		Laing 1983		6	1.98
		Jensen & Flyger 1983		0.10 - 2.4	0.033 - 0.79
		Punter 1983	d	2.6 - 5.3	0.86 - 1.7
		Viswanathan et al 1983		1.26 - 2.4	0.42 - 0.79
		Homans 1984		21.5	7.09
		Murphy & Cain 1985	d	0.39 - 4.26	0.13 - 1.41
		Roos et al 1985	d	0.101 - 0.136	0.033 - 0.45
		Roos et al 1985	d	0.77	0.25
		Don 1986	d	0.77	0.25
		Ahlstrom et al 1986	d	0.136 - 0.224	0.045 - 0.074
		Dravnieks et al 1986	d	0.51 - 4.05	0.168 - 1.34
		Hartigh 1986	d	0.01 - 0.292	**0.0033** - 0.096
		MacLeod et al 1986		0.69	0.23
		Poostchi et al 1986	d	0.99 - 1.85	0.33 - 0.61
		Poostchi et al 1986	r	3.72 - 4.02	1.23 - 1.33
		Cain et al 1988		1.4	0.46
		Dollnick et al 1988		0.384	0.13
		Stevens et al 1988	d	0.36 - 3.3	0.12 - 1.09
		De Wijk 1989		4.43	1.46
		Hermans 1989		0.15 - 0.214	0.049 - 0.071
		Cometto - Muniz & Cain 1990	d	5.4	1.78
		Cometto - Muniz 1993	d	5.4	1.78
		Scharfenberger 1990		0.5	0.16
		Cain & Gent 1991	d	3 - 9	1 - 3
		Laska & Hudson 1991	d	0.79	0.26
		Lea & Ford 1991		2	0.66
		Nagy 1991	d	3.1	1.02
		Nagy 1991	d	0.591	0.19
		Cometto - Muniz & Cain 1993	d	162	53
		Patterson et al 1993	d	5.4	1.78
		Stevens & Dadarwala 1993	d	0.48 - 38.4	0.16 - 13
		Dalton et al 1997a	d	0.61 - 5.5	0.20 - 1.8

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
36	**n - Butyl Alcohol cont.**	Dalton et al 1997b	d	8.2 - 15.8	2.7 - 5.2
		Harreveld & Heeres 1997		0.058 - 0.53	0.019 - 0.17
		Wysocki et al 1997	d	0.48 - 9.6	0.16 - 3.2
		Cometto - Muniz et al 1999	d	1.7 - 3.8	0.56 - 1.25
		Molhave et al 2000	d	11	3.63
		Ziemer et al 2000	d	0.15	0.049
		Feddes et al 2001	d	0.17	0.056
		Mannebeck & Mannebeck 2002	d	0.105 - 0.1739	0.035 - 0.057
		Smeets & Dalton 2002	d	42 - 54	14 - 18
		Nagata 2003	d	0.11	0.036
		Cometto - Muniz et al 2004	d	0.97	0.32
		Maxeiner & Mannebeck 2004	d	0.1323 - 0.1957	0.044 - 0.065
		Cometto - Muniz & Abraham 2008	d	0.024	0.008
		Polednik et al 2008	d	0.2 - 0.4	0.0660.13
		Maxeiner 2006	d	0.1071 - 0.1251	0.035 - 0.041
		Maxeiner 2007	d	0.111 - 0.130	0.037 - 0.043
		Ueno et al 2009		0.051	0.017
		Ueno et al 2009		0.26	0.086
		Ueno et al 2009		0.16	0.053
		Ueno et al 2009		0.42	0.14
		Cain et al 2010		0.48	0.16
		Nimmermark 2011		0.078 - 1.4	0.026 - 0.46
37	**sec - Butyl Alcohol**	Jung 1936	d	7.4	2.4
		Jung 1936	r	14.4	4.8
		Jones 1955c	r	80	26
		Laffort & Dravnieks 1973		9	3
		Hellman & Small 1974	d	0.4	0.12
		Hellman & Small 1974	r	1.2	0.41
		Bedborough & Trott 1979	d	3.3	1.1
		Punter 1983	d	59.1	19.5
		Punter 1983	d	41.8	13.8
		Cometto - Muniz & Cain 1993	d	285	94
		Cometto - Muniz 1993	d	285	94
		Ziemer et al 2000	d	0.13	**0.043**
		Nagata 2003	d	0.66	0.218
38	**tert - Butyl Alcohol**	Passy 1892c	d	10 - 20	3.3 - 6.6
		Backman 1917	r	36 - 40	11.875 - 13.195
		Jones 1955c	r	750	247
		Dravnieks & Laffort 1972		71	23
		Dravnieks 1974	d	2,900	957
		Nagy 1991	d	42	14

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
38	**tert - Butyl Alcohol cont.**	Cometto - Muniz & Cain 1993	d	1,827	603
		Cometto - Muniz 1993	d	1,827	603
		Ziemer et al 2000	d	24.2	7.98
		Nagata 2003	d	14	4.62
39	**n - Butylamine**	Scherberger et al 1960		<0.36	<0.12
		Sutton 1962a		<3	<1
		Hellman & Small 1973a,b, 1974	d	0.24	**0.08**
		Hellman & Small 1973a,b, 1974	r	0.72	0.24
		Laing et al 1978	r	41.7	13.9
		Nagata 2003	d	0.51	0.17
40	**n - Butyl Lactate**	Ziemer et al 2000	d	0.000000029	0.00000000485
41	**Butyl Mercaptan**	Allison & Katz 1919	d	18	4.9
		Katz & Talbert 1930	d	0.0037	0.001
		Deadman & Prigg 1959	d	0.0015	0.00041
		Blinova 1965		0.007 - 0.04	0.0019 - 0.0011
		Kniebes et al 1969		0.003	0.00081
		Wilby 1969	r	0.0027	0.00073
		Patte 1978	d	0.003	0.00081
		Patte & Punter 1979	d	0.003	0.00081
		Nagata 2003	d	0.00001	**0.0000027**
42	**p - tert Butyl Toluene**	Hine et al 1954	r	<30.5	<5.03
43	**Butyraldehyde**	Backman 1917	r	0.013 - 0.014	0.0044 - 0.0047
		Pliska & Janicek 1965		15	5.09
		Hellman & Small 1973a,b, 1974	d	<0.013	<0.0044
		Hellman & Small 1973a,b, 1974	r	0.027	0.0092
		Teranshi et al 1974		0.042	0.014
		Anon 1980	d	0.00084	**0.0003**
		Anon 1980	r	0.011	0.0037
		Hall & Andersson 1983	d	0.2	0.068
		Cristoph 1983	r	0.18 - 0.21	0.061 - 0.071
		Cometto - Muniz et al 1998a	d	8.8	2.98
		Cometto - Muniz 1999	d	8.8	2.98
		Nagata 2003	d	0.0019	0.0006
		Cometto - Muniz & Abraham 2010a	d	0.0013	0.0004
		Laska & Ringh 2010	d	0.1	0.034
44	**Camphor, synthetic**	Passy 1892a, 1892b	d	5	0.8
		Zwaardemaker 1914, 1927	d	0.016 - 2	**0.0026** - 0.32
		Backman 1917	r	0.76 - 0.88	0.12 - 0.14
		Ohma 1922	d	0.06	0.0096

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
44	**Camphor, synthetic cont.**	Hofmann & Kohlrausch 1925	r	2 - 33	0.32 - 5.3
		Mitsumoto 1926	r	4.4 - 45.0	0.71 - 7.2
		Tamman & Oelsen 1928	d	6 - 13	0.97 - 2.1
		Morimura 1934	r	1.16 - 32.5	0.19 - 5.2
		Gundlach & Kenway 1939	d	0.49	0.079
		Kleinschmidt 1983	r	3.35	0.54
		De Wijk 1989		2.84	0.46
45	**Caprolactam**	Krichevskaya 1968		0.3	0.065
46	**Carbon Dioxide**	Lotsch et al 1997		540,000 - 1,080,000	300,068 - 600,136
		Shusterman & Balmes 1997a, 1997b		486,000	270,000
		Melzner et al 2011	d	95,400	53,000
		Melzner et al 2011	d	81,000	45,000
		Melzner et al 2011	d	75,600	42,000
		Melzner et al 2011	d	70,200	**39,000**
47	**Carbon Disulfide**	Deadman & Prigg 1959	d	0.07	0.022
		Hildenskiold 1959		0.05	**0.016**
		Frantikova 1962		1.3	0.42
		Baikov 1963		0.08 - 0.5	0.026 - 0.16
		Leonardos et al 1969	r	0.65	0.21
		Naus 1982	d	0.1	0.032
		Naus 1982	r	1	0.32
		Kleinschmidt 1983	r	98.9	32
		Moriguchi et al 1983	d	0.11	0.04
		Don 1986	d	0.18	0.06
		Nagy 1991	d	3.9	1.25
		Nagy 1991	d	1.269	0.41
		Nagata 2003	d	0.65	0.21
48	**Carbon Tetrachloride**	Allison & Katz 1919		4,533	720
		Davis 1934		500	79
		Lehmann & Schmidt - Kehl 1936		900	143
		May 1966	d	1,260	200
		May 1966	r	1,600	254
		Leonardos et al 1969	r	135 - 630	21 - 100
		Belkov 1969		11.5 - 58	1.8 - 9
		Nikiforov 1970		10.58	**1.68**
		Dravnieks & Laffort 1972		280	45
		Dravnieks 1974	d	3700	588
		Punter 1983	d	884	140
		Nagata 2003	d	29	4.6
49	**Carbonyl Sulfide**	Polgar et al 1975		0.25	0.102
		Nagata 2003	d	0.14	**0.057**

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
50	**Chlorine**	Fieldner et al 1921		10	3.4
		Prentiss 1937		10	3.4
		Smolczyk & Cobler 1930		1.43 - 14.3	0.49 - 4.9
		Takhiroff 1957		0.8	0.28
		Beck 1959		0.15 - 0.3	0.05 - 0.10
		Styazhkin 1963		0.7	0.24
		Rupp & Henschler 1967	d	0.06 - 0.15	0.021 - 0.052
		Rupp & Henschler 1967	r	0.3	0.1
		Leonardos et al 1969	r	0.6	0.21
		Kramer 1976		3.2 - 7.8	1.10 - 2.69
		Dixon & Ikels 1977	d	0.23	0.08
		Naus 1982		3	1.03
		Naus 1982		10	3.45
		Randebrock 1986		0.18	0.062
		Nagata 2003		0.14	0.048
51	**Chlorine Dioxide**	Vincent et al 1946		42	15
52	**Chloroacetophenone**	Katz & Talbert 1930		0.10 - 0.70	**0.016** - 0.111
		Prentis 1937		0.2	0.032
53	**Chlorobenzene**	Backman 1917	r	7.5 - 8.1	1.6 - 1.8
		Mateson 1955		21.6	4.7
		Tarkhova 1965		0.4	**0.087**
		Leonardos et al 1969	r	0.97	0.21
		Smith & Hochstettler 1969	r	3	0.65
		Punter 1983	d	5.9	1.3
		Don 1986	d	1	0.217
		Nagy 1991	d	4.5	0.98
		Cometto - Muniz 1993	d	59.3	13
		Cometto - Muniz & Cain 1994	d	59.3	13
54	**Chlorodifluoromethane**	Braker & Mossman 1980		708,000	200,192
55	**Chloroform**	Passy 1893a	d	30	6.1
		Tempelaar 1913	d	3,000	614
		Backman 1917	r	14.1 - 15.1	2.9 - 3.1
		Allison & Katz 1919		3,300	676
		Grijns 1919		2,350	481
		Rocen 1920	d	730	150
		Rocen 1920	r	2,500	512
		Mitsumoto 1926	r	353.8 - 589.0	72.7 - 121
		Schley 1934	d	42	8.6
		Schley 1934	r	56	11
		Morimura 1934	r	480 - 622	99 - 128
		Lehmann & Schmidt - Kehl 1936		1,000 - 1,500	205 - 307
		Scherberger et al 1958	r	6,900	1,413

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
55	**Chloroform cont.**	Janicek et al 1960		3,700	758
		Naus 1962	d	3	0.6
		Dravnieks & Laffort 1972		150	31
		Dravnieks 1974	d	1,350	276
		Naus 1982	d	0.5	**0.1**
		Naus 1982	r	20	4.1
		Punter 1983	d	650	133
		Nagata 2003	d	19	3.9
56	**Chloropicrin**	Prentiss 1937		7.3	1.09
57	**β - Chloroprene**	Mnatsakanyan 1962		0.4 - 2.0	**0.11** - 0.55
58	**Chlorotoluene**	Blackman 1917	r	0.95 - 1.4	**0.18** - 0.27
59	**Citral**	Passy 1892a, 1892b	d	0.1 - 0.5	0.016 - 0.08
		Tempelaar 1913	d	0.062 - 0.1	0.010 - 0.016
		Zwaardemaker 1927	d	0.062 - 0.1	0.010 - 0.016
		Backman 1917	r	0.06 - 0.09	0.0097 - 0.014
		Ohma 1922	d	0.13	0.0209
		Schneider & Wolf 1955		0.027	0.0043
		Schneider et al 1958		0.12	0.0193
		Apell 1969		0.0005	0.00008
		Koster 1971	d	0.17 - 0.19	0.027 - 0.031
		Etzweiler et al 1980		0.02	0.032
		Randebrock 1986		0.00015	**0.000024**
60	**Cresol, all isomers**	**o - cresol**			
		Backman 1917	r	0.004	0.0009
		Stuiver 1958	d	0.0004	**0.00009**
		Kendall et al 1968	r	0.0028	0.00063
		Anon. 1980	d	0.0017	0.00038
		Anon. 1980	r	0.027	0.0061
		Moriguchi et al 1983	d	0.02	0.00452
		Schieberle et al 1988		0.0007 - 0.0027	0.00016 - 0.00061
		Nagata 2003	d	0.0012	0.00027
		Strube et al 2012		0.0078	0.0018
		m - cresol			
		Backman 1917	r	0.0007 - 0.0009	0.00016 - 0.00020
		Stuiver 1958	d	0.0004	0.00009
		Nader 1958	d	0.00022 - 0.035	**0.000050** - 0.0079
		Anon. 1980	d	0.00057	0.00013
		Anon. 1980	r	0.011	0.0025
		Nagata 2003	d	0.00044	0.0001
		p - cresol			
		Backman 1917	r	0.03 - 0.04	0.0068 - 0.0090
		Baldus 1936	d	0.0125	0.0028
		Baldus 1936	r	0.015	0.0034

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
60	**Cresol, all isomers cont.**	Stuiver 1958	d	0.00005	0.000011
		Leonardos et al1969	r	0.0044	0.00099
		Punter 1975, 1979	d	0.024	0.0054
		Anon. 1980	d	0.00018	0.000041
		Anon. 1980	r	0.0084	0.0019
		Schieberle et al 1988		0.0003 - 0.001	**0.00007** - 0.00023
		Schieberle & Grosch 1988		0.0003 - 0.001	0.00007 - 0.00023
		Blank et al 1989		0.0003 - 0.001	0.00007 - 0.00023
		Blank 1990		0.0003 - 0.001	0.00007 - 0.00023
		Nagata 2003	d	0.00024	0.000054
61	**Crotonaldehyde**	Katz & Talbert 1930	d	0.18 - 0.57	0.063 - 0.20
		Teranishi et al 1974		0.42	0.147
		Hall & Andersson 1983	d	1.7	0.59
		Nagata 2003	d	0.067	**0.02**
62	**Cumene**	Solomin 1964		0.06	0.012
		Elfimova 1966		0.025	0.0051
		Koster 1971	d	0.25	0.051
		Turk 1973	r	4.8 - 6.4	0.98 - 1.3
		Hellman & Small 1974	d	0.04	0.008
		Hellman & Small 1974	r	0.23	0.047
		Anon. 1980	d	0.074	0.025
		Anon. 1980	r	0.54	0.11
		Punter 1983	d	0.65	0.132
		Bahmuller 1983		0.017 - 1.19	0.035 - 0.242
		Nagy 1991	d	0.6	0.12
		Cometto - Muniz et al 1998b		5.3	1.08
		Cometto - Muniz 1999	d	5.3	1.08
		Nagata 2003	d	0.041	**0.008**
63	**Cumene Hydroperoxide**	Solomin 1964		0.03	0.0048
64	**Cyanogen**	Braker & Mossman 1980		>533	>500
65	**Cyanogen Chloride**	Prentiss 1937		2.5	0.994
66	**Cyclohexane**	Schley 1934	d	39	11
		Schley 1934	r	120	35
		Jones 1955c	d	900	261
		Alibaev 1970		1.8	**0.52**
		Stone et al 1972	d	35.6	10.3
		Dravnieks & Laffort 1972		315	91.5
		Laffort & Dravnieks 1973		165	48
		Dravnieks & Laffort 1972	d	2,700	784
		Nagata 2003	d	8.5	2.47
67	**Cyclohexanol**	Dobrinskiy 1964		0.24	**0.058**
		Punter 1983	d	0.64	0.156
		Van Thriel et al 2006	d	2.01	0.491

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
68	**Cyclohexanone**	Dobrinsky 1964		0.21	**0.052**
		Stone et al 1967	d	1.15	0.29
		Koster 1971	d	790 - 880	197 - 219
		Stone et al 1972	d	1.6	0.4
		Hellman & Small 1973a,b, 1974	d	0.48	0.12
		Hellman & Small 1973a,b, 1974	r	0.48	0.12
		Davis 1973	d	2	0.5
		Laing 1975	d	40	10
		Laing 1983		1.0 - 2.4	0.249 - 0.598
		Laska & Hudson 1991	d	0.88 - 1.2	0.219 - 0.299
		Ziemer et al 2000	d	1.1	0.27
		Van Thriel et al 2006	d	5.27	1.31
69	**Cyclohexene**	Deadman & Prigg 1959	d	0.6	0.18
70	**Cyclohexylamine**	Van Thriel et al 2006	d	9.83	2.42
71	**Cyclopentadiene**	Deadman & Prigg 1959	d	5	1.8
72	**Decaborane**	Krackow 1953		0.3	0.06
73	**1 - Decene**	Koszinowski & Piringer 1983		37	6.45
74	**Diacetone Alcohol**	Hellman & Small 1974	d	1.3	**0.27**
		Hellman & Small 1974	r	5.2	1.1
		Nagy 1991	d	60	13
		Nagy 1991	d	37.418	7.88
75	**Diacetyl**	Backman 1917	r	0.003 - 0.006	0.00085 - 0.00170
		Van Anrooij 1931	d	0.0025	0.0007
		Apell 1969		0.0026	0.00074
		Artho & Koch 1973		0.00001	0.0000028
		Punter 1975	d	0.000007	**0.0000019**
		Punter 1979	d	0.000007	0.0000019
		Hall & Andersson 1983	d	0.005	0.0014
		Bahnmuller 1983		0.0007 - 0.087	0.00020 - 0.247
		Randebrock 1986		10.2	2.9
		Blank 1990		0.015 - 0.030	0.0043 - 0.0085
		Blank et al 1992		0.01 - 0.02	0.0028 - 0.0057
		Nagata 2003	d	0.00018	0.000051
76	**Diallylamine**	Hine et al 1960		8	2
77	**Diborane**	Krackow 1953		2 - 4	1.8 - 3.5
78	**2,3 Dibromo-1-Chloro-propane**	Torkelson & Rowe 1981		0.1 - 0.3	0.010 - 0.031
79	**Dibutylamine**	Hellman & Small 1973a,b, 1974	d	0.42	**0.079**
		Hellman & Small 1973a,b, 1974	r	1.4	0.265
		Laing et al 1978	r	2.76	0.522

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
79	**Dibutylamine cont.**	Bahnmuller 1984		0.44 - 4.069	0.083 - 0.77
80	**Dibutyl Phthalate**	Menshikova 1972		0.26	0.023
81	**Dichloroacetic Acid**	Backman 1917	r	0.232	0.044
82	**Dichlorobenzene, o - isomer**	Backman 1917	r	0.12	**0.02**
		Hollingsworth et al 1958		<300	<50
		Punter 1983	d	4.2	0.699
83	**Dichlorobenzene, p - isomer**	Hollingsworth et al 1956		<90	<15
		Punter 1983	d	0.73	**0.121**
84	**Dichlorodifluoromethane**	Braker & Mossman 1980		988,000	199,790
85	**1,1 - Dichloroethane**	Rylova 1953		200	**49**
		Janicek et al 1960		5,500	1359
		Irish 1963		2,000 - 4,000	494 - 988
86	**1,2 Dichloroethylene, all isomers**	Lehmann & Schmidt - Kehl 1936		1,100	277
87	**2,4 - Dichlorophenol**	Punter 1983	d	0.00027	0.000041
		Strube et al 2012		0.0068	0.00102
88	**1,3 - Dichloropropene**	Torkelson & Oyen 1977		<4.5	<0.99
89	**Dicyclopentadiene**	Kinkead et al 1971b		0.016	0.003
		Hellman & Small 1974	d	0.06	0.011
		Hellman & Small 1974	r	0.11	0.02
		Ventura et al 1997		0.001	**0.00019**
90	**Diethanolamine**	England et al 1978	r	1.2	0.279
91	**Diethylamine**	Geier 1936	d	0.01 - 0.1	**0.0033** - 0.033
		Geier 1936	r	2.25 - 5	0.75 - 1.67
		Kosiborod 1968		0.084	0.028
		Hellman & Small 1973a	d	0.42	0.14
		Hellman & Small 1973a	r	1.5	0.5
		Hellman & Small 1974	d	0.06	0.02
		Hellman & Small 1974	r	0.18	0.06
		Cormack et al 1974		0.09	0.03
		Laing et al 1978	r	42.9	14.3
		Tkachev 1978		0.044 - 0.558	0.015 - 0.187
		Anon. 1980	d	0.09	0.03
		Anon. 1980	r	0.9	0.3
		Laing 1982	d	4	1.3
		Nagata 2003	d	0.14	0.0468
92	**2 - Diethylaminoethanol**	Hellman & Small 1973a,b, 1974	d	0.05	**0.01**
		Hellman & Small 1973a,b, 1974	r	0.19	0.04
		England et al 1978	r	1.2	0.25

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
93	**Diethylbenzenes, mixed isomers**	Nagata 2003	d	0.052	0.0095
		Nagata 2003	d	0.39	0.071
		Nagata 2003	d	0.0021	**0.00038**
94	**Diethyl Ketone**	Backman 1917	r	3.8	1.1
		May 1966	d	33	9.4
		May 1966	r	49	14
		Dravnieks 1974	d	3	**0.85**
95	**Diethyl Phthalate**	Wunsche et al 1995	d	0.33 - 3.3	0.036 - 0.363
96	**Diisobutyl Ketone**	Hellman & Small 1973a,b, 1974	d	<0.6	**<0.103**
		Hellman & Small 1973a,b, 1974	r	1.8	0.309
		Nagy 1991	d	9.3	1.6
97	**Diisopropylamine**	Hellman & Small 1974	d	0.56	**0.14**
		Hellman & Small 1974	r	1.6	0.39
		England et al 1978	r	17.4	4.2
98	**N,N - Dimethylacetamide**	Leonardos et al 1969	r	170	48
99	**Dimethylamine**	Geier 1936	d	0.65 - 1.0	0.35 - 0.54
		Geier 1936	r	2.2 - 3.0	1.2 - 1.6
		Taylor & Bodurtha 1960		1.1	0.6
		Leonardos et al 1969	r	0.085	0.046
		Stephens 1971		0.16	0.087
		Prusakov et al 1976		0.01 - 0.03	0.005 - 0.016
		Tkachev 1978		0.03	0.016
		Anon. 1980	d	0.0014	**0.00076**
		Anon. 1980	r	0.023	0.012
		Nagata 2003	d	0.059	0.032
		Van Thriel et al 2006	d	7.75	4.2
100	**Dimethylaniline**	Backman 1917	r	0.8 - 1.0	0.16 - 0.20
		Geier 1936	d	0.005 - 0.1	**0.001** - 0.02
		Geier 1936	r	0.05 - 0.25	0.010 - 0.050
		Deadman & Prigg 1959	d	0.012	0.0024
101	**Dimethyl Disulfide**	Wilby 1969	r	0.029	0.0075
		Lindvall 1970	d	0.003 - 0.014	0.00078 - 0.00363
		Selyuzhitskii 1972		3.5	0.908
		Bedborough & Trott 1979	d	0.046	0.012
		Anon 1980	d	0.0011 - 0.0020	**0.00029** - 0.00052
		Anon 1980	r	0.011 - 0.017	0.00286 - 0.0044
		Moriguchi et al 1983	d	0.007	0.0018
		Ahlstrom et al 1986	d	0.050 - 0.078	0.0130 - 0.0202
		Nagy 1991	d	0.066	0.017
		Gijs et al 2000		0.82	0.213

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
101	**Dimethyl Disulfide cont.**	Greenman et al 2004		5.6	1.45
		Nagata 2003	d	0.0084	0.0022
102	**Dimethyl Ether**	Nagy 1991	d	430	228
		Nagy 1991	d	303.967	**161**
103	**Dimethyl Formamide**	Odoshashvili 1962		0.14	**0.047**
		Leonardos et al 1969	r	300	100
104	**1,1 - Dimethylhydrazine**	Jacobson et al 1955	d	15 - 35	6.1 - 14
		Rumsey &Cesta 1970		<0.75	**<0.31**
105	**Dimethyl Sulfide**	Katz & Talbert 1930		0.0094	0.0037
		Nevers & Oister 1965		0.0035	0.0014
		Guadagni 1966		0.003	0.0012
		Leonardos et al 1969	r	0.0025	0.001
		Wilby 1969	r	0.0063	0.0025
		Lindvall 1970	d	0.002 - 0.03	0.00079 - 0.012
		Laffort 1968b		0.014	0.0055
		Laffort & Dravnieks 1973		0.014	0.0055
		Hamanabe et al 1969		0.025	0.0098
		Selyuzhitskii 1972		0.75	0.295
		Ifeadi 1972		0.65	0.256
		Cormack et al 1974		0.0075	0.003
		Nishida et al 1975	d	0.0025 - 0.065	0.00098 - 0.026
		Nishida et al 1979	d	0.16	0.063
		Anon 1980	d	0.0003	**0.00012**
		Anon 1980	r	0.0058	0.0023
		Moschandreas & Jones 1983	d	0.027	0.011
		Moschandreas & Jones 1983	r	0.049	0.019
		Randebrock 1986		20.6	8.11
		Nagy 1991	d	0.051	0.020
		Nagata 2003	d	0.0075	0.003
		Glindemann et al 2006	d	0.001	0.00039
106	**4,6 - Dinitro - o - cresol**	Kurtschatowa & Dawidkowa 1970		0.004 - 0.021	**0.00049** - 0.00259
107	**1,4 - Dioxane**	Wirth & Klimmer 1937	d	10	2.8
		May 1966	d	620	172
		May 1966	r	1000	278
		Koster 1968a, 1971	d	45 - 9,400	12 - 2609
		Dravnieks & Laffort 1972		30.6	8.5
		Hellman & Small 1973a,b, 1974	d	2.9	**0.8**
		Hellman & Small 1973a,b, 1974	r	6.5	1.8
		Dravnieks 1974	d	270	75
		Nagy 1991	d	46	12.8

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
108	**1,3 - Dioxolane**	Hellman & Small 1974	d	51	**16.8**
		Hellman & Small 1974	r	192	63.4
109	**Diphenylamine**	Backman 1917	r	0.15 - 0.17	**0.022** - 0.025
		Nagy 1991	d	1.3	0.188
110	**Dodecyl Mercaptan**	Kendall et al 1968	r	0.0008	0.000097
		Patte 1978	d	0.0000009	**0.00000011**
		Patte & Punter 1979	d	0.0000009	0.00000011
111	**Epichlorohydrin**	Toxicity Data Sheet 1959		38 - 46	10.04 - 12.15
		Fomin 1966		0.3	**0.08**
112	**Ethane**	Mullins 1955	r	899,000	730973
		Laffort & Dravnieks 1973		25,000	**20328**
113	**Ethanolamine**	Weeks et al 1960	d	6.5	**2.6**
		Weeks et al 1960	r	60	24
114	**2 - Ethoxyethanol**	May 1966	d	90	24
		May 1966	r	180	49
		Hellman & Small 1973a,b, 1974	d	1.1	**0.3**
		Hellman & Small 1973a,b, 1974	r	2	0.54
		Nagy 1991	d	11.6	3.15
		Nagata 2003	d	2.1	0.57
115	**2-(2-Ethoxyethoxy) - ethanol**	Hellman & Small 1973a,b, 1974	d	<1.2	**<0.219**
		Hellman & Small 1973a,b, 1974	r	6	1.09
116	**2 - Ethoxyethyl Acetate**	Hellman & Small 1973a,b, 1974	d	0.3	0.06
		Hellman & Small 1973a,b, 1974	r	0.7	0.13
		Nagy 1991	d	0.48	0.089
		Nagata 2003	d	0.26	**0.048**
117	**Ethyl Acetate**	Backman 1917	r	15 - 17.5	4.2 - 4.9
		Allison & Katz 1919		686	190
		Jung 1936	d	3.6	1
		Jung 1936	r	3.6 - 5.4	1.0 - 1.5
		Jones 1955c	d	155	43
		Clausen et al 1955	d	4.8	1.33
		Gofmekler 1960		0.6	0.17
		Janicek et al 1960		1120	311
		May 1966	d	180	50
		May 1966	r	270	75
		Laffort & Dravnieks 1973		27	7.5
		Hellman & Small 1973a, 1974	d	23	6.4
		Hellman & Small 1973a, 1974	r	48	13.3

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
117	**Ethyl Acetate cont.**	Anon. 1980	d	0.9	0.25
		Anon. 1980	r	5	1.39
		Bahnmuller 1983		3.7 - 25	1.027 - 6.9
		Cristoph 1983	r	4.6 - 5.0	1.3 - 1.4
		Randebrock 1986		0.34	0.09
		Scharfenberger 1990		141	39
		Cometto - Muniz & Cain 1991	d	623	173
		Cometto - Muniz 1993	d	623	173
		Nagy 1991	d	28	8
		Ziemer et al 2000	d	4.6	1.28
		Nagata 2003	d	3.1	0.86
		Higuchi & Masuda 2004	d	2.0 - 3.0	0.555 - 0.833
		Komthong et al 2006		1,030	286
		Van Thriel et al 2006	d	5.36	1.49
		Cometto - Muniz et al 2008	d	0.88	0.24
		Ueno et al 2009		1.3	0.36
		Ueno et al 2009		6.1	1.69
		Ueno et al 2009		4.7	1.30
		Ueno et al 2009		4.3	1.19
118	**Ethyl Acrylate**	Leonardos et al 1969	r	0.0019	0.00046
		Hellman & Small 1973a, 1974	d	0.001	0.00024
		Hellman & Small 1973a, 1974	r	0.0015	0.00037
		Anon. 1980	d	0.00082	0.0002
		Anon. 1980	r	0.0053	0.0013
		Piringer & Granzer 1984		0.001	0.00024
		Nagy 1991	d	0.013	0.0032
		Nagata 2003	d	0.0011	0.00026
		Van Thriel et al 2006	d	0.000027	0.0000066
119	**Ethyl Alcohol**	Passy 1892c	d	250	133
		Parker & Stabler 1913	r	17	9
		Backman 1917	r	175 - 200	93 - 106
		Grijns 1919		2,600	1380
		Zwaardemaker 1927		2,600	1380
		Henning 1924	d	183	97
		Jung 1936	d	7.8	4.1
		Jung 1936	r	11.7 - 14	6.2 - 7.4
		Balavoine 1943		10,000	5,307
		Mullins 1955	r	9,230	4,898
		Scherberger et al 1958	r	665	353
		Janicek et al 1960		884	469
		Naus 1962	d	2	1.1
		Pliska & Janicek 1965		76,000	40,334
		Ubaidullaev 1966b		7.1	3.77

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
119	**Ethyl Alcohol cont.**	Guadagni 1966		100	53
		May 1966	d	93	49
		May 1966	r	190	101
		Leonardos et al 1969	r	19	10
		Dravnieks & Laffort 1972		640	340
		Dravnieks 1974	d	1,350	716
		Nishida et al 1979	d	302	159
		Anon. 1980	d	0.64	0.34
		Anon. 1980	r	11.6	6.2
		Naus 1982	d	2	1.06
		Naus 1982	r	20	10.61
		Cristoph 1983	r	8.7 - 9.2	4.6 - 4.9
		Cometto - Muniz & Cain 1990		154	82
		Cometto - Muniz 1993	d	154	82
		Scharfenberger 1990		988	524
		Nagy 1991	d	36	19
		Nagata 2003	d	0.99	0.525
		Cain et al 2005	d	0.17	**0.09**
		Cometto - Muniz & Abraham 2008	d	0.62	0.329
120	**Ethylamine**	Tkachev 1969		0.05	**0.027**
		Hellman & Small 1974	d	0.5	0.27
		Hellman & Small 1974	r	1.5	0.81
		Laing et al 1978	r	6.5	3.5
		Nagata 2003	d	0.083	0.045
121	**Ethyl Amyl Ketone**	Toxicity Data Sheet 1958b		31	5.9
122	**Ethyl Benzene**	Ivanov 1964		2 - 2.6	0.46 - 0.60
		Koster 1971	d	0.4	0.092
		Nagy 1991	d	1.9	0.44
		Khiari et al 0992		<0.01	**<0.002**
		Cometto - Muniz 1993	d	78.3	18
		Cometto - Muniz & Cain 1994	d	78.3	18
		Nagata 2003	d	0.73	0.17
		Cometto - Muniz & Abraham 2009b	d	0.026	0.006
123	**Ethyl Bromide**	Backman 1917		12.1 - 16	**2.7** - 3.6
124	**Ethyl Chloride**	Backman 1917	r	10 - 12	**3.8** - 4.5
		Nagy 1991	d	>1000	>379
125	**Ethylene**	Mullins 1955	r	1,180	1,029
		Deadman & Prigg 1959	d	125	109
		Krasovitskaya & Malyarova 1968		20	**17**
		Laffort & Dravnieks 1973		1,100	959

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
125	**Ethylene cont.**	Hellman & Small 1974	d	310	270
		Hellman & Small 1974	r	480	418
126	**Ethylene Chlorohydrin**	Semenova et al 1980		1.2	0.36
127	**Ethylenediamine**	Hellman & Small 1974	d	3.2	1.3
128	**Ethylene Dibromide**	Olmstead 1972	r	<77	<10
129	**Ethylene Dichloride**	McCawley 1942		1,200 - 4,000	297 - 988
		Jones 1955c	d	1,500	371
		Borisova 1957		17.5 - 23.2	**4.3** - 5.7
		Scherberger et al 1958	r	820	203
		Irish 1963		200	49
		May 1966	d	450	111
		May 1966	r	750	185
		Dravnieks & O'Donnell 1971		190	47
		Hellman & Small 1974	d	25	6
		Hellman & Small 1974	r	165	41
		Kleinschmidt 1983	r	350	86
130	**Ethylene Glycol**	Nagy 1991	d	13	5.12
131	**Ethyleneimine**	Carpenter et al 1948		3.6	2
		Berzins 1967		1.25 - 3.5	**0.71** - 1.99
132	**Ethylene Oxide**	Jacobson et al 1956	d	1,260	690
		Yuldashev 1965		1.5	**0.82**
		Hellman & Small 1974	d	470	257
		Hellman & Small 1974	r	900	493
133	**Ethyl Ether**	Passy 1892a,b,d	d	0.5 - 4	**0.165** - 1.32
		Allison & Katz 1919		5,833	1,924
		Grijns 1919		<50	<16.49
		Henning 1924	d	0.75	0.25
		Zwaardemaker 1927		1	0.33
		Jung 1936	d	35	12
		Jung 1936	r	35	12
		Scherberger et al 1958	r	210	69
		Flemming & Johnstone 1977	r	4.8	1.58
		Nagy 1991	d	0.95	0.31
134	**Ethyl Formate**	Backman 1917	r	54 - 61	18 - 20
		Nagata 2003	d	8.1	**2.67**
		Van Thriel et al 2006	d	90.9	30
135	**Ethylidene Norbomene**	Kinkead et al 1971a		0.035 - 0.07	**0.007** - 0.014
		Hellman & Small 1974	d	0.1	0.02
		Hellman & Small 1974	r	0.4	0.08
136	**Ethyl Mercaptan**	Allison & Katz 1919		46	18
		Katz & Talbert 1930	d	0.00066 - 0.0076	0.00026 - 0.0030
		Thomas et al 1943		0.005	0.002
		Stuiver 1958	d	0.0001	0.0004

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
136	**Ethyl Mercaptan cont.**	Sales 1958		0.0025 - 0.0045	0.00098 - 0.0018
		Blinova 1965		0.006 - 0.03	0.002 - 0.01
		Endo et al 1967		0.00065	0.00026
		Leonardos et al 1969	r	0.0025	0.0098
		Wilby 1969	r	0.001	0.0004
		Blanchard 1976		0.016	0.0063
		Selyuzhitskii et al 1978		0.000095	0.000037
		Whisman et al 1978	d	0.00025 - 0.0005	0.000098 - 0.00020
		Bedborough & Trott 1979	d	0.00033	0.00013
		Anon 1980	d	0.000043	0.000017
		Anon 1980	r	0.00073	0.00029
		Cristoph 1983	r	0.0008 - 0.0009	0.00031 - 0.00035
		Stevens et al 1987		0.0019 - 0.021	0.00075 - 0.00826
		Stevens & Cain 1987b	d	0.0019 - 0.021	0.00075 - 0.00826
		Nagata 2003	d	0.000022	**0.0000087**
137	**N - Ethylmorpholine**	Hellman & Small 1974	d	0.4	**0.085**
		Hellman & Small 1974	r	1.2	0.25
138	**Ethyl Silicate**	Smyth & Seaton 1940	d	<720	<85
		Hellman & Small 1974	d	31	**3.6**
		Hellman & Small 1974	r	43	5
139	**Fluorine**	Belles et al 1965		0.15 - 0.30	**0.097** - 0.19
140	**Formaldehyde**	Backman 1917	r	0.033 - 0.036	**0.027** - 0.029
		Melekhina 1958		0.07	0.057
		Buchberg et al 1961		1.1 - 2.2	0.90 - 1.8
		Pliska & Janicek 1965		12,000	9,770
		Sgibnev 1968		0.3 - 0.4	0.24 - 0.33
		Leonardos et al 1969	r	1.2	0.98
		Feldman & Bonashevskya 1971		0.073	0.059
		Takhirov 1974		0.065	0.053
		Makeicheva 1978		0.077	0.063
		Anon. 1980	d	0.49	0.4
		Anon. 1980	r	2.3	1.9
		Berglund et al 1984	d	0.06	0.049
		Ahstrom et al 1986b	d	0.06	0.049
		Berglund et al 1987	d	0.14 - 0.21	0.114 - 0.171
		Winneke et al 1988		0.15 - 0.29	0.122 - 0.236
		Nagy 1991	d	2.2	1.8
		Berglund & Nordin 1992	d	0.066 - 0.11	0.054 - 0.09
		Berglund & Esfandabad 1992		0.18	0.15
		Berglund & Esfandabad 1992		0.69	0.56
		Nagata 2003	d	0.6	0.49

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
141	**Formic Acid**	Passy 1893b, 1893c	d	25 - 50	13 - 27
		Zwaardemaker 1914	d	640	340
		Backman 1917	r	21 - 24	11 - 13
		Schley 1934		3.0 - 6.0	1.6 - 3.2
		Guadagni 1966		450	239
		Naus 1982	d	2	1.06
		Naus 1982	r	20	10.63
		Kleinschmidt 1983	r	453	241
		Cometto - Muniz et al 1998a		14.5	7.7
		Cometto - Muniz 1999	d	14.5	7.7
		Van Thriel et al 2006	d	12.4	6.59
		Cometto - Muniz & Abraham 2010b	d	0.98	**0.52**
142	**Furan**	Nagata 2003	d	28	10.06
143	**Furfural**	Ubaidullaev 1961		1	0.254
		Apell 1969		0.008	**0.002**
		Makeicheva 1978		0.98	0.249
		Bedborough & Trott 1979	d	0.25	0.0636
		Nagy 1991	d	2.8	0.713
144	**Furfuryl Alcohol**	Jacobson et al 1958	d	32	8
145	**Glutaraldehyde**	Colwell 1976	r	0.16	0.039
		Cain et al 2007b	d	0.0015	**0.00037**
146	**Halothane**	Flemming & Johnstone 1977	r	267	33
147	**Heptane, all isomers**	Patty & Yant 1929		410	100
		Mullins 1955	r	2,240	547
		Jones 1955c	d	750	183
		May 1966	d	930	227
		May 1966	r	1,350	329
		Dravnieks & Laffort 1972		870	212
		Laffort & Dravnieks 1973		165	40
		Dravnieks 1974	d	3,000	732
		Nagy 1991	d	110	27
		Nagata 2003	d	2.7	0.66
		Nagata 2003	d	1.7	**0.41**
		Nagata 2003	d	3.4	0.83
		Nagata 2003	d	156	38
		Nagata 2003	d	18	4.39
		Nagata 2003	d	3.9	0.95
148	**Hexachlorocyclopenta-diene**	Treon et al 1955		1.7	0.15
149	**1,6 Hexamethylene Diisocyanate**	Kimmerle 1971		0.035 - 0.07	**0.005** - 0.010

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
150	**n - Hexane**	Patty & Yant 1929		875	248
		Laffort & Dravnieks 1973		230	65
		De Wijk 1989		107	30
		Nagata 2003	d	5.3	1.5
151	**Hexane, all isomers, except n - Hexane**	Nagata 2003	d	5.8	1.68
		Nagata 2003	d	25	7
		Nagata 2003	d	31	9
		Nagata 2003	d	70	20
		Nagata 2003	d	1.5	**0.426**
152	**1,6 - Hexanediamine**	Kulakov 1964		0.0032	0.00067
153	**1 - Hexene**	Nagata 2003	d	0.48	0.139
154	**sec - Hexyl Acetate**	Stone et al 1972	d	2.3	0.39
		Hellman & Small 1974	d	<0.4	**<0.068**
		Hellman & Small 1974	r	1.4	0.237
155	**n - Hexyl Alcohol**	Backman 1917	r	1.0 - 1.3	0.24 - 0.31
		Mullins 1955	r	9.94	2.38
		Pliska 1962		65	16
		Cain 1969	r	3.5	0.837
		Stone et al 1972	d	1.5	0.359
		Dravnieks & Laffort 1972		0.01	**0.0024**
		Dravnieks 1974	d	0.3	0.072
		Hellman & Small 1974	d	0.04	0.01
		Hellman & Small 1974	r	0.38	0.091
		Punter 1983	d	1.93	0.46
		Cristoph 1983	r	0.10 - 0.15	0.024 - 0.036
		Cometto - Muniz & Cain 1990	d	4	0.96
		Cometto - Muniz 1993	d	4	0.96
		Ferreira et al 1998		0.74	0.18
		Nagata 2003	d	0.025	0.006
		Komthong et al 2006		12.3	2.9
		Cometto - Muniz & Abraham 2008	d	0.034	0.0081
156	**Hexylene Glycol**	Nagy 1991	d	19	3.93
157	**Hydrazine**	Jacobson et al 1955	d	3.9 - 5.2	**3.0** - 4.0
		Jacobson et al 1958	d	5.2	4
158	**Hydrogen Chloride**	Schley 1934		4.5	3.02
		Elfimova 1959		0.1 - 0.2	0.067 - 0.134
		Heyroth 1963	d	1.5 - 7.5	1.01 - 5.03
		Styazhkin 1963		0.2	0.134
		Melekhina 1968	d	0.39	0.262
		Leonardos et al 1969	r	15	10
		Takhirov 1974		0.38	0.255

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
158	**Hydrogen Chloride cont.**	Naus 1982	d	7	4.69
		Naus 1982	r	15	10
		Van Thriel et al 2006	d	0.09	**0.06**
159	**Hydrogen Cyanide**	Sherrard 1928		6	5.43
		Smolczyk & Cobler 1930		<1.1	<1
		Prentiss 1937		1	0.905
		Artho & Koch 1973		0.01 - 0.1	**0.009** - 0.09
		Braker & Mossman 1980	r	2.2 - 5.6	1.99 - 5.07
160	**Hydrogen Fluoride**	Sadilova 1968		0.03	0.04
161	**Hydrogen Selenide**	Dudley & Miller 1941		<1	<0.3
162	**Hydrogen Sulfide**	Valentin 1848, 1850		2	1.4
		Lehmann 1897		<2	<1.4
		Kulka & Homma 1910		0.2 - 0.3	0.14 - 0.22
		Henderson & Haggard 1922		<0.001	<0.00072
		Henning 1924	d	0.0001	0.00007
		Katz & Talbert 1930	d	0.18	0.13
		Thomas et al 1943		0.035	0.025
		Loginova 1957		0.04	0.029
		Duan - Fen - Djuy 1959		0.012 - 0.03	0.0086 - 0.022
		Sanders & Dechant 1961		0.04 - 0.10	0.029 - 0.072
		Baikov 1963		0.014 - 0.03	0.010 - 0.022
		Young & Adams 1966	d	0.008 - 0.011	0.0057 - 0.0079
		Cederlof et al 1966	d	0.01	0.0072
		Sakuma et al 1967		0.007	0.005
		Endo et al 1967		1.4	1
		Basmadzhieva & Argirova 1968		0.012	0.0086
		Adams et al 1968	d	0.0047 - 0.0090	0.0034 - 0.0065
		Leonardos et al 1969	r	0.00066 - 0.0066	0.00047 - 0.0047
		Pomeroy & Cruse 1969		0.0042 - 0.042	0.003 - 0.030
		Wilby 1969	r	0.0063	0.0045
		Lindvall 1970	d	0.00021 - 0.0016	0.00015 - 0.0017
		Stephens 1971		0.067	0.048
		Randebrock 1971		0.012	0.0086
		Nishida et al 1975	d	0.0014 - 0.055	0.0010 - 0.039
		Winkler 1975	d	0.003	0.0022
		Winkler 1975	r	0.03	0.022
		Hill & Barth 1976		0.0007	0.0005
		Williams et al 1977	d	0.27	0.019
		Logtenberg 1978	d	0.002	0.0014
		Nishida et al 1979	d	0.074	0.053
		Winneke et al 1979	d	0.00265	0.0019
		Thiele 1979	d	0.0016	0.0011

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
162	**Hydrogen Sulfide cont.**	Bedborough & Trott 1979	d	0.0036	0.0026
		Brunekreef & Harssema 1980		0.0011 - 0.0024	0.00079 - 0.0017
		Anon. 1980	d	0.0007	0.0005
		Anon. 1980	r	0.0078	0.0056
		Thiele et al 1981		0.0013 - 0.0053	0.00093 - 0.0038
		Thiele 1982		0.0028	0.062
		Naus 1982	d	0.1	0.072
		Naus 1982	r	5	3.6
		Jensen & Flyger 1983		0.0038 - 0.0067	0.0027 - 0.0048
		Kobal & Thiele 1983		0.0022	0.0016
		Bahmuller 1983		0.0014 - 0.023	0.001 - 0.017
		Moriguchi et al 1983	d	0.0007	0.0005
		Bahmuller 1984		0.0012 - 0.0073	0.00086 - 0.0052
		Thiele 1984		0.0018	0.0013
		Roos et al 1985	d	0.00085 - 0.00105	0.00061 - 0.00075
		Roos et al 1985	d	0.0004 - 0.00043	0.00029 - 0.00031
		Don 1986	d	0.0004 - 0.00043	0.00029 - 0.00031
		Hoshika et al 1993	d	0.0004 - 0.00043	0.00029 - 0.00031
		Randebrock 1986		0.0096	0.0069
		Heeres et al 1986		0.0004 - 0.0052	0.00029 - 0.0037
		Dollnick et al 1988		0.00166	0.0012
		Winneke et al 1988		0.0015 - 0.0026	0.0011 - 0.0019
		Hermans 1989		0.000056 - 0.001545	**0.00004** - 0.0011
		Nagy 1991	d	0.0055	0.0039
		Hoshika et al 1993	d	0.0007	0.0005
		Lotsch et al 1997		0.14 - 2.8	0.10 - 2
		Mannebeck & Mannebeck 2002	d	0.000491 - 0.000946	0.00035 - 0.00068
		Nagata 2003	d	0.00057	0.00041
		Greenman et al 2004		0.022	0.0157
		McGinely & McGinley 2004		0.00070 - 0.003	0.0005 - 0.0022
		McGinely & McGinley 2004	r	0.00064 - 0.0013	0.00046 - 0.00093
		McGinely & McGinley 2004	d	0.00057 - 0.00142	0.00041 - 0.0010
		McGinely & McGinley 2004	r	0.00071 - 0.0032	0.00051 - 0.0023
		Glindemann et al 2006	d	0.001	0.00072
		Ueno et al 2009		0.00045	0.00032
		Ueno et al 2009		0.0018	0.013
163	**Indene**	Deadman & Prigg 1959	d	0.02	0.0042
		Moriguchi et al 1983	d	0.013	**0.0027**
164	**Iodine**	Randebrock 1986		10.1	0.973
165	**Iodoform**	Passy 1893a	d	0.06 - 0.7	0.0037 - 0.043
		Berthelot 1901		0.0003 - 0.03	**0.000019** - 0.0019

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
165	**Iodoform cont.**	Backman 1917	r	0.095	0.0059
		Allison & Katz 1919		18	1.12
		Zwaardemaker 1927		0.03	0.0019
		Cancho et al 2001		<0.14	<0.0087
166	**Isoamyl Acetate**	Hermanides 1909	r	0.09	0.017
		Zwaardemaker 1914	d	0.09	0.017
		Backman 1917	r	0.18 - 0.29	0.034 - 0.054
		Katz & Talbert 1930	d	0.018	0.0034
		Jung 1936	d	0.20	0.038
		Jung 1936	r	0.2	0.038
		Kerka & Humphreys 1956		0.2	0.038
		Pliska & Janicek 1965		5	0.94
		Appell 1969		0.004	**0.00075**
		Nishida et al 1979	d	1,100	209
		Punter 1983	d	0.070 - 0.084	0.013 - 0.016
		Cristoph 1983	r	0.015 - 0.02	0.0028 - 0.0038
		Don 1986	d	0.075	0.014
		Lea & Ford 1991		0.5	0.094
		Laska & Hudson 1991	d	0.13 - 0.14	0.024 - 0.026
		Hoshika et al 1997	r	8	1.5
		Langridge 2004		0.2289	0.043
		Langridge 2004		0.0107	0.002
		Atanasova et al 2005	d	0.018 - 0.919	0.0034 - 0.173
		Atanasova et al 2005	r	0.067 - 0.918	0.013 - 0.172
		Komthong et al 2006		1,950	366
167	**Isoamyl Alcohol**	Passy 1892c	d	0.1	0.028
		Backman 1917	r	0.26	0.072
		Jung 1936	d	0.08	0.022
		Jung 1936	r	0.16	0.044
		Bahmuller 1983		0.019 - 0.547	0.0053 - 0.1517
		Bahmuller 1984		0.030 - 0.16	0.0083 - 0.0444
		Dollnick et al 1988		0.116	0.032
		Guth 1997		0.125	0.035
		Guth 1997		6.3	1.75
		Ferreira et al 1998		2.8	0.777
		Nagata 2003	d	0.0061	**0.00169**
168	**Isobutyl Acetate**	Backman 1917	r	1.9 - 2.1	0.40 - 0.44
		May 1966	d	17	3.6
		May 1966	r	34	7.2
		Hellman & Small 1974	d	1.7	0.36
		Hellman & Small 1974	r	2.4	0.51
		Cristoph 1983	r	0.42 - 0.52	0.088 - 0.109
		Nagata 2003	d	0.038	**0.008**
		Komthong et al 2006		21.1 - 612	4.4 - 129

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
169	**Isobutyl Alcohol**	Passy 1892c	d	1	0.33
		Zwaardemaker 1914	d	500	165
		Backman 1917	r	0.2 - 0.4	0.066 - 0.13
		Jones 1955c	r	31	10
		May 1966	d	120	40
		May 1966	r	160	53
		Laffort & Dravnieks 1973		3	1
		Hellman & Small 1973a,b, 1974	d	2	0.66
		Hellman & Small 1973a,b, 1974	r	5.4	1.8
		Anon. 1980	d	0.036	0.012
		Anon. 1980	r	0.66	0.218
		Punter 1983	d	3.8 - 8.1	1.25 - 2.67
		Cristoph 1983	r	0.7 - 1.0	0.23 - 0.33
		Nagy 1991	d	2.64	0.87
		Nagy 1991	d	1.73	0.57
		Guth 1997		0.64	0.21
		Guth 1997		200	66
		Nagata 2003	d	0.033	**0.011**
170	**Isobutyraldehyde**	Hellman & Small 1973a,b, 1974	d	0.14	0.0475
		Hellman & Small 1973a,b, 1974	r	0.41	0.139
		Amoore 1977	d	0.015	0.0051
		Hendriks 304	d	0.022	0.0075
		Nagata 2003	d	0.001	**0.00034**
171	**Isooctyl Alcohol**	Tsulaya et al 1972		0.26	0.049
		Nagata 2003	d	0.049	**0.0092**
172	**Isophorone**	Hellman & Small 1974	d	1.1	0.19
		Hellman & Small 1974	r	3	0.53
		Ziemer et al 2000	d	0.0017	**0.0003**
173	**Isoprene**	Artho & Koch 1973		1 - 10	0.359 - 3.59
		Nagata 2003	d	0.13	**0.047**
174	**Isopropyl Acetate**	Backman 1917	r	27 - 33	6.5 - 7.9
		Jung 1936	d	1.9	0.45
		Jung 1936	r	1.9 - 2.9	0.45 - 0.69
		May 1966	d	140	34
		May 1966	r	170	41
		Hellman & Small 1974	d	2.1	0.5
		Hellman & Small 1974	r	3.8	0.91
		Scharfenberger 1990		68	16
		Nagy 1991	d	9.4	2.25
		Nagata 2003	d	0.67	**0.16**

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
175	**Isopropyl Alcohol**	Passy 1892c	d	40	16
		Backman 1917	r	18 - 24	7.3 - 9.8
		Jung 1936	d	3.9 - 32.4	1.6 - 13.2
		Jung 1936	r	7.8 - 31.2	3.2 - 12.7
		Scherberger et al 1958	r	500	203
		Cheesman & Kirkby 1959	d	43 - 290	17 - 118
		May 1966	d	90	37
		May 1966	r	120	49
		Gorlova 1970		2.5	**1**
		Koster 1968a, 1971	d	64 - 5,400	26 - 2,197
		Dravnieks & Laffort 1972		57.4	23.4
		Dravnieks 1974	d	1,500	610
		Hellman & Small 1974	d	8	3.3
		Hellman & Small 1974	r	18.8	7.6
		Scharfenberger 1990		491	200
		Nagy 1991	d	180	73
		Cometto - Muniz & Cain 1993		1,245	507
		Cometto - Muniz 1993, 1999	d	1,245	507
		Smith & Duffy 1995	d	103	42
		Smith & Duffy 1965	r	228	93
		Smeets & Dalton 2002	d	28 - 98	11 - 40
		Nagata 2003	d	65	26
176	**Isopropyl amine**	Hellman & Small 1974	d	0.5	0.21
		Hellman & Small 1974	r	1.7	0.7
		Nagata 2003	d	0.06	**0.025**
177	**Isopropyl Ether**	Hellman & Small 1974	d	0.07	**0.017**
		Hellman & Small 1974	r	0.22	0.053
178	**d-Limonene**	Fuller et al 1964	r	0.058	0.01
		Apell 1969		0.01	**0.0018**
		Dravnieks et al 1986	d	1.7	0.31
		Nagata 2003	d	0.21	0.04
		Langridge 2004		1.6878	0.3
		Langridge 2004		0.0539	0.01
179	**Maleic Anhydride**	Grigorieva 1964		1.0 - 1.3	**0.25** - 0.32
180	**Mercaptoethanol**	Vermeulen & Collin 2006		0.24	0.075
181	**Mesityl Oxide**	Toxicity Data Sheet 1957		48	12
		Hellman & Small 1974	d	0.07	**0.017**
		Hellman & Small 1974	r	0.2	0.05
182	**Methacrylic Acid**	Piringer & Granzer 1984		10	2.84
		Nagy 1991	d	1.9	**0.54**
183	**Methacrylonitrile**	Pozzani et al 1968	d	19	6.9
		Nagata 2003	d	8.1	**2.95**
184	**Methane**	Laffort & Gortan 1987		1,900,000	2,896,197

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
185	**2 - Methoxyethanol**	May 1966	d	190	61
		May 1966	r	280	90
		Hellman & Small 1973a,b, 1974	d	<0.3	**<0.096**
		Hellman & Small 1973a,b, 1974	r	0.7	0.22
186	**2 - Methoxyethyl Acetate**	Hellman & Small 1973a,b, 1974	d	1.6	**0.33**
		Hellman & Small 1973a,b, 1974	r	3.1	0.64
187	**1 - Methoxy - 2 - Propanol**	Stewart et al 1970	d	37	10
		Nagy 1991	d	121	33
		Nagy 1991	d	30.908	**8.39**
188	**1-Methoxy-2-Propyl Acetate**	Nagy 1991	d	0.7	0.13
		Ziemer et al 2000	d	0.016	**0.0029**
189	**Methyl Acetate**	Zwaardemaker 1914, 1927	d	2	0.66
		Backman 1917	r	67	22
		Gofmekler 1960		0.5	**0.17**
		Janicek et al 1960		5250	1733
		Naus 1962	d	0.7	0.231
		May 1966	d	550	182
		May 1966	r	900	297
		Anon. 1980	d	22	7.3
		Anon. 1980	r	63	20.8
		Scharfenberger 1990		579	191
		Cometto - Muniz & Cain 1991		8,628	2,848
		Cometto - Muniz 1993	d	8,628	2,848
		Nagata 2003	d	5.1	1.68
190	**Methyl Acrylate**	Bezpalkova 1967a, b		0.017	0.0048
		Anon. 1980	d	0.01	**0.003**
		Anon. 1980	r	0.06	0.020
		Bahnmuller 1984		0.015 - 0.088	0.004 - 0.025
		Priinger & Granzer 1984		0.05	0.0142
		Nagy 1991	d	0.061	0.0173
		Nagata 2003	d	0.012	0.0034
191	**Methyl Alcohol**	Passy 1892c	d	1,000	764
		Zwaardemaker 1914	d	600	458
		Backman 1917	r	900 - 1,000	687 - 763
		Grijns 1919		2,150	1,643
		Zwaardemaker 1927		2,150	1,643
		Jung 1936	d	23.4 - 54.6	17.9 - 41.7
		Jung 1936	r	54.6 - 62.4	41.7 - 47.7
		Gavaudan et al 1948		150	115
		Mullins 1955	r	19,300	14,746

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
191	**Methyl Alcohol cont.**	Scherberger et al 1958	r	1,950	1,490
		Chao - Chen - Tzi 1959		4.3	3.3
		Janicek et al 1960		4,000	3,056
		Pliska & Janicek 1965		260,000	198,656
		May 1966	d	7,800	5,960
		May 1966	r	11700	8,940
		Ubaidullaev 1966a		4.5	3.4
		Leonardos et al 1969	r	130	99
		Hellman & Small 1974	d	5.5	4.2
		Hellman & Small 1974	r	69	53
		Anon. 1980	d	74	57
		Anon. 1980	r	260	199
		Naus 1982	d	4	**3.05**
		Naus 1982	r	10	7.63
		Cometto - Muniz & Cain 1990	d	2,096	1,599
		Cometto - Muniz 1993	d	2,096	1,599
		Scharfenberger 1990		1,975	1,507
		Nagata 2003	d	43	33
192	**Methylamine**	Leonardos et al 1969	r	0.027	0.021
		Nishida et al 1975	d	0.065	0.0512
		Nishida et al 1979	d	6.1	4.8
		Anon. 1980	d	0.0012	**0.0009**
		Anon. 1980	r	0.012	0.009
		Hill & Barth 1976		0.027	0.021
		Nagy 1991	d	0.23	0.18
		Nagata 2003	d	0.046	0.036
193	**Methyl n - Amyl Ketone**	Stone et al 1962	d	0.9	0.19
		Pangborn et al 1964	d	0.82	0.18
		Teranishi et al 1974		0.84	0.18
		Hall & Andersson 1983	d	1.3	0.28
		Nagy 1991	d	1.2	0.26
		Nagy 1991	d	0.398	0.085
		Cometto - Muniz & Cain 1993	d	3.3	0.71
		Cometto - Muniz 1993	d	3.3	0.71
		Cometto - Muniz et al 1999	d	0.29 - 0.65	0.062 - 0.139
		Ziemer et al 2000	d	0.045	0.01
		Nagata 2003	d	0.032	0.007
		Cometto - Muniz et al 2004	d	0.47	0.1
		Cain et al 2008	d	0.062	0.013
		Cometto - Muniz et al 2008	d	0.023	0.0049
		Cometto - Muniz & Abraham 2009a	d	0.023	0.0049
		Yang et al 2008		0.0035	**0.00075**

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
194	**N - Methyl Aniline**	Backman 1917	r	6.9 - 8.6	**1.6** - 2.0
195	**2 - Methylbutyl Acetate**	Cristoph 1983	r	0.14 - 0.21	**0.026** - 0.039
196	**Methyl tert Butyl Ether**	Smith & Duffy 1995	d	0.11	**0.03**
		Smith & Duffy 1995	r	0.22	0.06
		Prah et al 1994	d	0.63	0.17
		Schulman 2001	d	0.63	0.17
197	**Methyl n - Butyl Ketone**	Backman 1917	r	0.28 - 0.35	0.068 - 0.085
		Hall & Andersson 1983	d	4.7	1.15
		Nagata 2003	d	0.098	**0.024**
198	**Methyl Chloride**	Leonardos et al 1969	r	>21	>10
199	**Methyl Chloroform**	Scherberger et al 1958	r	1,650	302
		May 1966	d	2,100	385
		May 1966	r	3,900	715
		Kendall et al 1968	r	88	16
		Don 1986	d	5.3	**0.97**
200	**Methyl - 2 - Cyanoacrylate**	McGee et al 1968		4.5 - 13.5	**0.99** - 2.97
201	**Methyl Cyclohexane**	Nagata 2003	d	0.6	0.149
202	**2 - Methyl Cyclohexanone**	Van Thriel et al 2006	d	0.83	0.181
203	**Methylene Bisphenyl Isocyanate**	Woolrich 1982		4	0.39
204	**Methylene Chloride**	Lehmann & Schmidt - Kehl 1936		1,100	317
		Scherberger et al 1958	r	1,530	440
		May 1966	d	550	158
		May 1966	r	790	227
		Leonardos et al 1969	r	730	210
		Basmadshijewa et al 1970	d	4.1 - 33.2	**1.2** - 9.6
		Don 1986	d	640	184
		Nagata 2003	d	560	161
205	**Methyl Ethyl Ketone**	Backman 1917	r	63 - 70	21 - 24
		May 1966	d	80	27
		May 1966	r	163	55
		Leonardos et al 1969	r	29	9.8
		Hartung et al1971		7	2.4
		Mukhitov & Azimbekov 1971		0.75	0.25
		Dravnieks & Laffort 1972		22	7.5
		Artho & Koch 1973		100 - 1,000	34 - 339
		Dravnieks 1974	d	250	85
		Hellman & Small 1974	d	5.8	2
		Hellman & Small 1974	r	16	5.4
		Anon. 1980	d	8.4	2.8
		Anon. 1980	r	29	9.8
		Hall & Andersson 1983	d	61	21
		Doty et al 1988	d	16.5 - 23.9	5.6 - 8.1

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
205	**Methyl Ethyl Ketone cont.**	Scharfenberger 1990		126	43
		Doty 1991	d	2.9 - 51.6	0.983 - 17.5
		Nagy 1991	d	4.8	1.63
		Ziemer et al 2000	d	0.21	**0.07**
		Nagata 2003	d	1.3	0.44
206	**Methyl Formate**	Backman 1917	r	165 - 180	**67** - 73
		May 1966	d	5,000	2,035
		May 1966	r	6,900	2,809
		Nagata 2003	d	325	132
207	**Methyl Hydrazine**	Jacobson et al 1955		1.9 - 5.7	**1** - 3
208	**Methyl Isoamyl Ketone**	Hellman & Small 1974	d	0.06	0.013
		Hellman & Small 1974	r	0.23	0.049
		Nagy 1911	d	0.63	0.135
		Nagata 2003	d	0.0099	**0.0021**
209	**Methyl Isobutyl Ketone**	Backman 1917	r	0.6 - 0.8	0.15 - 0.2
		Middleton 1956	r	1.9	0.46
		May 1966	d	32	7.8
		May 1966	r	64	16
		Stone et al 1967b, 1972	d	0.97 - 9.7	0.24 - 2.4
		Steinmetz et al 1969	d	1.21	0.3
		Leonardos et al 1969	r	1.9	0.46
		Hellman & Small 1974	d	0.4	0.1
		Hellman & Small 1974	r	1.1	0.27
		Anon. 1980	d	0.7	0.17
		Anon. 1980	r	2.8	0.68
		Dravnieks et al 1986	d	0.14	**0.03**
		Nagy 1911	d	6.3	1.54
		Dalton et al 2000	d	41	10.00
		Ziemer et al 2000	d	1.1	0.27
		Nagata 2003	d	0.7	0.17
210	**Methyl Isocyanate**	Kimmerle & Eben 1964		5	2.14
211	**Methyl Isopropyl Ketone**	Backman 1917	r	15 - 17	4.3 - 4.8
		Nagata 2003	d	1.8	**0.51**
212	**Methyl Mercaptan**	Katz & Talbert 1930	d	0.081	0.041
		Bozza & Colombo 1949		1	0.51
		Freudenberg & Reichert 1955		0.0005	0.00025
		Guadagni 1966		0.0002	0.0001
		Endo et al 1967		1.1	0.56
		Leonardos et al 1969	r	0.0042	0.0021
		Wilby 1969	r	0.002	0.001
		Hamanabe et al 1969		0.0002	0.0001
		Sanders et al1970		0.0019	0.00097
		Selyuzhitskii 1972		0.0005	0.00025

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
212	**Methyl Mercaptan cont.**	Artho & Koch 1973		0.000000000001	**0.00000000000051**
		Blanchard 1976		0.003	0.0015
		Williams et al 1977	d	0.0000003	0.0000002
		Nishida et al 1979	d	0.038	0.019
		Bedborough & Trott 1979	d	0.00016	0.000081
		Anon. 1980	d	0.00024	0.00012
		Anon. 1980	r	0.0013	0.00066
		Nagy 1991	d	0.0024	0.0012
		Nagata 2003	d	0.00014	0.000071
		Greenman et al 2004		0.00048	0.00024
		Clindemann et al 2006	d	0.001	0.00051
213	**Methyl Methacrylate**	Filatova 1962		0.2	0.049
		Leonardos et al 1969	r	0.85	0.21
		Hellman & Small 1973a,b, 1974	d	0.2	0.049
		Hellman & Small 1973a,b, 1974	r	1.4	0.34
		Holland 1974		0.057	**0.014**
		Anon. 1980	d	0.62	0.15
		Anon. 1980	r	1.9	0.46
		Piringer & Granzer 1984		0.7	0.17
		Nagy 1991	d	2.7	0.66
		Nagata 2003	d	0.86	0.21
214	**2 - Methylnaphthalene**	Moriguchi et al 1983	d	0.004	0.00069
215	**Methyl Parathion**	Akhmedov 1968		0.0125	0.0012
216	**4 - Methyl - 2 - Pentanol**	Hellman & Small 1974	d	1.4	**0.335**
		Hellman & Small 1974	r	2.2	0.526
217	**Methyl Propyl Ketone**	Backman 1917	r	11 - 15	3.1 - 4.3
		May 1966	d	27	7.7
		May 1966	r	48	13.6
		Hall & Andersson 1983	d	22	6.24
		Laska & Hudson 1991	d	6.7 - 8.3	1.9 - 2.4
		Cometto - Muniz & Cain 1993	d	30.1	8.54
		Cometto - Muniz 1993	d	30.1	8.54
		Patterson et al 1993	d	9.1	2.58
		Nagata 2003	d	0.098	**0.028**
		Komthong et al 2006		230	65
		Cometto - Muniz et al 2008	d	0.35	0.099
		Cometto - Muniz & Abraham 2009a	d	0.35	0.099
218	**1 - Methyl - 2 - Pyrrolidone**	Nagy 1991	d	41	10
		Nagy 1991	d	17.113	**4.22**

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
219	**Methyl Styrene**	Wolf et al 1956		48 - 240	9.9 - 49.7
		Minaev 1966		0.1	**0.02**
		Hellman & Small 1974	d	0.25	0.05
		Hellman & Small 1974	r	0.75	0.16
		Nagy 1991	d	2.2	0.46
220	**Methyl Vinyl Ketone**	Martirosyan 1970		0.5	0.174
221	**Monochloroacetic Acid**	Backman 1917	r	0.6	0.155
		Smith & Hochstettler 1969	r	0.05	**0.013**
222	**Morpholine**	Hellman & Small 1973a,b, 1974	d	0.04	**0.01**
		Hellman & Small 1973a,b, 1974	r	0.25	0.07
223	**Naphthalene**	Backman 1917	r	0.05 - 0.055	0.0095 - 0.0105
		Mitsumoto 1926	r	4.0 - 4.4	0.76 - 0.84
		Hesse 1928	r	0.3	0.057
		Morimura 1934	r	3.37 - 5.34	0.64 - 1.02
		Robbins 1951		<1.6	<0.31
		Punter 1983	d	0.2	0.038
		Moriguchi et al 1983	d	0.007	**0.0013**
		Savenhed et al 1985	d	0.01 - 0.04	0.0019 - 0.0076
		Nagy 1991	d	0.45	0.086
224	**1 - Naphthylamine**	Backman 1917		0.14 - 0.29	**0.024** - 0.050
225	**2 - Naphthylamine**	Backman 1917	r	1.4 - 1.9	**0.24** - 0.32
226	**Nickel Carbonyl**	Armit 1907		3.5	**0.5**
		Kincaid 1956		7 - 21	1.0 - 3.0
227	**Nicotine**	Walker et al 1996		0.066	0.0099
228	**Nitric Acid**	Melekhina 1968	d	0.7	0.27
229	**Nitrobenzene**	Hermanides 1909	r	0.0412	0.0082
		Zwaardemaker 1914, 1927	d	0.04 - 0.041	0.0079 - 0.0081
		Backman 1917	r	0.34 - 0.70	0.068 - 0.14
		Allison & Katz 1919		146	29
		Henning 1924	d	0.0065	0.0013
		Katz & Talbert 1930	d	9.6	1.9
		Van Anrooij 1931	d	0.019	0.0038
		Janicek et al 1960		19	3.78
		Andrcescheva 1964		0.0182	0.0036
		Gavaudan & Poussel 1966		0.15	0.03
		Leonardos et al 1969	r	0.024	0.0048
		Randebrock 1971		0.002	**0.0004**
		Ozturk 1976	d	0.363	0.072
		Naus 1982	d	0.2	0.04
		Naus 1982	r	20	3.97
		Randebrock 1986		0.0053	0.0011

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
230	**Nitrogen Dioxide**	Beck 1959		0.2 - 1.0	0.1 - 0.5
		Henschler et al 1960	d	0.2 - 1.0	0.1 - 0.5
		Shalamberidze 1967		0.23	0.12
		Rumsey & Cesta 1970		<1	<0.5
		Knuth 1973		0.11	**0.058**
		Prusakov et al 1976		0.2 - 0.26	0.11 - 0.14
		Braker & Mossman 1980		<9.4	<5
		Nagata 2003		0.23	0.12
231	**Nitromethane**	Nagy 1991	d	124	50
232	**1 - Nitropropane**	Dravnieks 1974	d	510	140
		Dravnieks & Laffort 1972		28.2	**7.7**
233	**2 - Nitropropane**	Treon & Dutra 1952		297 - 1,050	82 - 288
		Hine et al 1978	r	580	159
		Crawford et al 1984	d	18	**4.94**
234	**N - Nitrosodimethyl Amine**	Prusakov et al 1976		0.024 - 0.04	**0.0079** - 0.013
235	**Nonane**	Mullins 1955	r	108	21
		Laffort & Dravnieks 1973		60	11
		Nagata 2003	d	12	**2.3**
236	**Octane, all isomers**	Jones 1955c	d	550	118
		May 1966	d	710	152
		May 1966	r	1,100	235
		Laffort & Dravnieks 1973		71	15
		Nagy 1991	d	61.8	13
		Nagy 1991	d	90.102	19
		Nagata 2003	d	8	1.71
		Nagata 2003	d	3.1	**0.66**
237	**1 - Octanol**	Backman 1917	r	0.005 - 0.008	0.0009 - 0.0015
		Rcoen 1920	r	0.005	**0.0009**
		Gavaudan et al 1948		0.02	0.0038
		Mullins 1955	r	5.44	1.02
		Pliska & Janicek 1960		0.14	0.026
		Pliska 1962		9	1.69
		Stone et al 1967	d	0.05	0.009
		Cain 1969	r	0.5	0.09
		Punter 1983	d	0.73	0.137
		Cristoph 1983	r	0.03 - 0.05	0.0056 - 0.009
		Cometto - Muniz & Cain 1990	d	0.037	0.0069
		Cometto - Muniz 1993	d	0.037	0.0069
		Nagata 2003	d	0.014	0.0026
		Commetto - Muniz & Abraham 2008	d	0.023	0.0043
		Yang et al 2008		0.022	0.0041

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds mg/m³	Odor Thresholds ppm
238	**1 - Octene**	Dravnieks & Laffort 1972		0.33	0.07
		Dravnieks 1974	d	5	1.09
		Kosinowski & Piringer 1983		37	8.06
		Cometto - Muniz 1993	d	945	206
		Cometto - Muniz & Cain 1994	d	945	206
		Nagata 2003	d	0.0046	**0.001**
239	**Oxygen Difluoride**	Lester & Adams 1965		0.22	0.0996
240	**Ozone**	Witheridge & Yaglou 1939		0.02 - 0.03	0.010 - 0.015
		Wilska 1951		<0.2	<0.10
		Beck 1959		<0.04	<0.02
		Henschler et al 1960		<0.04	<0.020
		Buchberg et al 1961		0.07 - 0.5	0.036 - 0.25
		Eglite 1968		0.015	0.0076
		Nagata 2003	d	0.0064	**0.0033**
		Cain et al 2007a	d	0.014	0.0071
241	**Pentaborane**	Krackow 1963		2.5	0.97
242	**Pentane, all isomers**	Patty & Yant 1929		1450	491
		Mullins 1955	r	3,090	1,147
		Laffort & Dravnieks 1973		350	119
		Nagata 2003	d	4.1	1.39
		Nagata 2003	d	3.8	**1.29**
243	**2,4 - Pentanedione**	Hellman & Small 1974	d	0.04	**0.0098**
		Hellman & Small 1974	r	0.08	0.0195
244	**Pentanol, all isomers**	Backman 1917	r	1.0 - 1.2	0.28 - 0.33
		Allison & Katz 1919		225	62
		Jung 1936	d	0.4 - 0.81	0.11 - 0.22
		Jung 1936	r	1.62	0.45
		Janicek et al 1960		11	3.05
		Naus 1962	d	4	1.11
		Pliska & Janicek 1965		1,100	305
		Gavaudan & Poussel 1966		0.4	0.11
		May 1966	d	35	9.71
		May 1966	r	80	22.00
		Stone et al 1972	d	1.2	0.33
		Baikov et al 1973		0.1	0.028
		Hellman & Small 1974	d	0.8	0.22
		Hellman & Small 1974	r	1.1	0.31
		Naus 1982	d	4	1.11
		Naus 1982	r	30	8.32
		Punter 1983	d	2	0.55
		Cristoph 1983	r	1.0 - 1.1	0.28 - 0.30
		Cometto - Muniz & Cain 1990	d	5	1.39
		Cometto - Muniz 1993	d	5	1.39

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
244	**Pentanol, all isomers cont.**	Lindell 1991	d	1.3	0.36
		Ziemer et al 2000	d	0.02	**0.0055**
		Nagata 2003	d	0.36	0.10
		Yang et al 2008		0.153	0.04
		Nagata 2003	d	1	0.28
		Passy 1892c	d	20 - 40	5.5 - 11
		Backman 1917	r	2.0 - 3.0	0.55 - 0.83
		Nagata 2003	d	0.32	0.089
		Backman 1917	r	1.4 - 1.7	0.39 - 0.47
		Hellman & Small 1973a,b, 1974	d	0.14	0.039
		Hellman & Small 1973a,b, 1974	r	0.83	0.23
		Cristoph 1983	r	0.9 - 1.0	0.25 - 0.28
		Komthong et al 2006		329	91
		Nagata 2003	d	1	0.28
245	**Perchloroethylene**	Carpenter 1937		<340	<50
		May 1966	d	320	47
		May 1966	r	480	71
		Leonardos et al 1969	r	32	5
		Anon. 1980	d	12	2
		Anon. 1980	r	55	8
		Torkelson & Rowe 1981		340	50
		Don 1986	d	8.1 - 8.3	1.19 - 1.22
		Hoshika et al 1993	d	8.1 - 8.3	1.19 - 1.22
		Hoshika et al 1993	d	12	2
		Nagata 2003	d	5.2	**0.767**
246	**Perchloryl Fluoride**	Braker & Mossman 1980		42	14.58
247	**Phenol**	Grijns 1906		2.2 - 6.8	0.57 - 1.8
		Zwaardemaker 1914, 1927	d	4	1
		Backman 1917	r	0.13 - 0.26	0.034 - 0.068
		Henning 1924	d	1.2	0.31
		Mukhitov 1962, 1963		0.022	0.0057
		Itskovich & Vinogradova 1962		3	0.78
		Pogosyan 1965		0.022	0.0057
		Komeev 1965		0.0172	**0.0045**
		Makhinya 1966		0.022	0.0057
		Basmadzhieva & Argirova 1968		0.021	0.0055
		Leonardos et al 1969	r	0.18	0.047
		Takhirov 1974		0.022	0.0057
		Punter 1975, 1979	d	0.8	0.21
		Makeicheva 1978		0.027	0.007

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
247	**Phenol cont.**	Anon. 1980	d	0.046	0.012
		Anon. 1980	r	0.22	0.057
		Naus 1982	d	0.2	0.2
		Naus 1982	r	20	20
		Punter 1983	d	0.23	0.06
		Moriguchi et al 1983	d	0.046	0.012
		Kohler & Homans 1980		5.8 - 7.5	1.51 - 1.95
		Homans 1984		5.8 - 7.5	1.51 - 1.95
		Hoshika et al 1993	d	0.039	0.010
		Don 1986	d	0.039	0.010
		Nagy 1991	d	0.5	0.130
		Hoshika et al 1993	d	0.046	0.012
		Nagata 2003	d	0.021	0.0055
248	**Phenyl Mercaptan**	Katz & Talbert 1930	d	0.0012	0.00027
		Stuiver 1958	d	0.00014	**0.00003**
249	**Phosgene**	Fieldner et al 1921		23	5.7
		Suchier 1929		4	1
		Schley 1934	d	0.5	**0.12**
		Schley 1934	r	0.5 - 1	0.12 - 0.25
		Prentiss 1937		4.4	1.09
		Patty 1962c		2	0.49
		Leonardos et al 1 969	r	4	1
250	**Phosphine**	Valentin 1848		1.4	1
		Valentin 1850		0.13	0.094
		Singh et al 1967	d	7	5
		Berck 1968	r	<2	<1.4
		Leonardos et al 1969	r	0.03	0.022
		Dumas & Bond 1974	d	>280	>201
		Fluck 1976	r	0.014 - 2.8	**0.010** - 2.014
251	**Phthalic Anhydride**	Slavgorodskiy 1968		0.32	0.053
252	**Picolines, all isomers**	Hellman & Small 1974	d	0.05	0.0131
		Hellman & Small 1974	r	0.09	0.0236
		Moriguchi et al 1983	d	0.01	**0.0026**
253	**Piperdine**	Geier 1936	d	0.5	**0.14**
		Geier 1936	r	2	0.57
		Nawakowski 1980		<7	<2
254	**Propane**	Patty & Yant 1929		36,000	19,964
		Laffort & Dravnieks 1973		22,000	12,200
		Nagata 2003		2,700	**1,497**
255	**Propionaldehyde**	Backman 1917	r	0.02	0.0084
		Pliska & Janicek 1965		240	101
		Hartung et al 1971		1.7	0.716
		Knuth 1973		0.026	0.011

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
255	**Propionaldehyde cont.**	Hellman & Small 1974	d	0.02	0.008
		Hellman & Small 1974	r	0.1	0.042
		Teranishi et al 1974		0.02	0.008
		Bedborough & Trott 1979	d	0.014	0.006
		Anon 1980	d	0.0036	0.0015
		Anon 1980	r	0.036	0.015
		Hall & Andersson 1983	d	0.69	0.29
		Cristoph 1983	d	0.33 - 0.40	0.139 - 0.168
		Nagy 1991	d	0.21	0.088
		Nagata 2003	d	0.0024	**0.001**
		Cometto - Muniz & Abraham 2010a	d	0.0048	0.002
256	**Propionic Acid**	Passy 1893b, 1893c	d	0.05	0.017
		Backman 1917	r	0.5	0.17
		Grijns 1919		0.6	0.2
		Mitsumoto 1926	r	1.7 - 2.55	0.56 - 0.84
		Hesse 1926	r	4.6	1.5
		Morimura 1934	r	1.77 - 2.38	0.58 - 0.79
		Stone 1963a, 1963c	d	0.39 - 0.68	0.13 - 0.22
		Stone & Bosley 1965	d	0.89	0.29
		Goldenberg 1967	d	0.003	**0.00099**
		Hellman & Small 1974	d	0.08	0.026
		Hellman & Small 1974	r	0.1	0.033
		Anon. 1980	d	0.0051	0.0017
		Anon. 1980	r	0.025	0.0083
		Punter 1983	d	0.44 - 0.58	0.15 - 0.19
		Dollnick et al 1988		0.147	0.049
		Walker et al 1990		14.1	4.65
		Nagy 1991	d	1.2	0.4
		Walker et al 1996		0.3 - 3	0.099 - 0.99
		Nagata 2003	d	0.017	0.0056
		Van Thriel et al 2006	d	1	0.33
257	**n - Propyl Acetate**	Backman 1917	r	12	2.9
		Jung 1936	d	0.35	0.084
		Jung 1936	r	0.35 - 0.62	0.084 - 0.15
		May 1966	d	70	17
		May 1966	r	110	26
		Hellman & Small 1974	d	0.2	**0.048**
		Hellman & Small 1974	r	0.6	0.14
		Cometto - Muniz & Cain 1991	d	104	25
		Cometto - Muniz & Cain 1991	d	104	25
		Nagata 2003	d	1	0.239
		Komthong et al 2006		363	87

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
258	**Propyl Alcohol**	Passy 1892c	d	5 - 10	2.0 - 4.1
		Backman 1917	r	3 - 5	1.2 - 2.0
		Jung 1936	d	0.8 - 8	0.33 - 3.3
		Jung 1936	r	8 - 24	3.3 - 9.8
		Jones 1955c	d	140	57
		Janicek et al 1960		540	220
		Pliska & Janicek 1965		25,000	10,172
		Guadagni 1966		9	3.7
		May 1966	d	80	33
		May 1966	r	150	61
		Khachaturyan et al 1968		1.25	0.51
		Cain 1969	r	660	269
		Corbit & Engen 1971		46 - 51	19 - 21
		Stone et al 1972	d	2.8	1.1
		Dravnieks & Laffort 1972		32.3	13
		Dravnieks 1974	d	100	41
		Hellman & Small 1974	d	<0.075	**<0.031**
		Hellman & Small 1974	r	0.2	0.081
		Laing 1975	d	100	41
		Naus 1982	d	2	0.81
		Naus 1982	r	20	8
		Punter 1983	d	5.9	2.4
		Cristoph 1983	r	2.9 - 3.2	1.18 - 1.3
		Cometto - Muniz & Cain 1990, 1993	d	27.5 - 35	11 - 14
		Cometto - Muniz 1993	d	27.5 - 35	11 - 14
		Scharfenberger 1990		16	6.5
		Nagata 2003	d	0.24	0.098
259	**Propylene**	Krasovitskaya & Malyarova 1968		17.3	**10.1**
		Laffort & Dravnieks 1973		170	99
		Hellman & Small 1974	d	38	22.1
		Hellman & Small 1974	r	115	67
		Nagata 2003	d	22	13
260	**Propylene Dichloride**	Hellman & Small 1974	d	1.2	**0.26**
		Hellman & Small 1974	r	2.4	0.52
		Nagy 1991	d	40	8.66
261	**Propylene Glycol**	Nagy 1991	d	16	5.14
262	**Propylene Glycol Dinitrate**	Stewart et al 1974	d	1.6	0.236
263	**Propylene Oxide**	Jacobson et al 1956	d	473	199
		Hellman & Small 1974	d	24	**10**
		Hellman & Small 1974	r	84	35

Table 6.3 – Odor Threshold Values, cont.

Bold = Lowest Value Reported

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
264	**Pyridine**	Hermanides 1909	r	0.16	0.05
		Zwaardemaker 1914, 1927	d	0.04	0.012
		Backman 1917	r	0.2	0.062
		Allison & Katz 1919		32	9.9
		Katz & Talbert 1930	d	0.74	0.23
		Van Anrooij 1931	d	0.078	0.024
		Geier 1936	d	0.09	0.029
		Geier 1936	r	0.095	0.029
		Jones 1955c	d	40	12
		Sales 1958		0.42	0.13
		Janicek et al 1960		4.6	1.4
		Sutton 1962b		<3.2	<0.99
		Kristesashvili 1965		0.21	0.065
		Leonardos et al 1969	r	0.067	0.021
		Dravnieks & Laffort 1972		0.33	0.1
		Laffort & Dravnieks 1973		0.74	0.23
		Dravnieks 1974	d	6	1.9
		Amoore & Buttery 1978	d	2.4	0.74
		Laing et al 1978	r	2.4	0.74
		Hangartner 1981		0.08 - 2.9	0.025 - 0.90
		Naus 1982	d	1	0.31
		Naus 1982	r	10	3.1
		Moriguchi et al 1983	d	0.023	**0.007**
		Bahnmuller 1983		0.132 - 1.21	0.041 - 0.374
		Ahlstrom et al 1986a	d	0.124 - 0.146	0.038 - 0.045
		Amoore 1986a,b	d	2.1	0.65
		Don 1986	d	0.12	0.04
		Hartigh 1986	d	0.15 - 0.29	0.046 - 0.090
		MacLeod et al 1986		0.054	0.017
		Cain et al 1987	d	0.34	0.11
		Steven et al 1988	d	0.13 - 1.2	0.040 - 0.371
		Cometto - Muniz & Cain 1990		4.1	1.27
		Cometto - Muniz 1993	d	4.1	1.27
		Cain & Gent 1991	d	0.32	0.1
		Laska & Hudson 1991	d	0.039	0.012
		Nagy 1991	d	1.5	0.46
		Berglund & Esfandabad 1992		0.31	0.1
		Berglund & Esfandabad 1992		2.5	0.77
		Nordin et al 1997		0.34	0.11
		Nagata 2003	d	0.2	0.062
		Cain et al 2010	d	0.32	0.1

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
265	**Quinoline**	Geier 1936	d	0.03	**0.0057**
		Geier 1936	r	0.05 - 0.1	0.0095 - 0.019
		Gundlach & Kenway 1939	d	28	5.3
266	**Quinone**	Backman 1917	r	0.047 - 0.050	**0.0106** - 0.0113
		Oglesby et al 1947		0.44	0.1
267	**Styrene, Monomer**	Wolf et al 1956		43 - 258	10 - 61
		Deadman & Prigg 1959	d	0.11	0.026
		Li - Shen 1961		0.02	0.0047
		Stalker 1963	d	0.073	0.017
		Muhlen 1968	r	4.3	1
		Leonardos et al 1969	r	0.2 - 0.4	0.047 - 0.094
		Smith & Hochstettler 1969	r	0.2	0.047
		Dravnieks & Laffort 1972		1.7	0.4
		Hellman & Small 1973a,b, 1974	d	0.22 - 0.64	0.052 - 0.15
		Hellman & Small 1973a,b, 1974	r	0.64	0.15
		Dravnieks 1974	d	8	1.9
		Anon. 1980	d	0.14	0.033
		Anon. 1980	r	0.73	0.17
		Don 1986	d	0.068	0.016
		Hoshika et al 1993	d	0.068	0.016
		Randebrock 1986		0.012	**0.0028**
		Nagy 1991	d	1.3	0.305
		Hoshika et al 1993	d	0.14	0.033
		Nagata 2003	d	0.15	0.035
		Dalton et al 2007	d	26.4	6.2
268	**Sulfur Dioxide**	Holmes et al 1915	d	5 - 10	1.9 - 3.8
		Holmes et al 1915	r	10 - 13	3.8 - 5.0
		Smolczyk & Cobler 1930		<4	<1.5
		Thomas et al 1943		1.3 - 1.6	0.50 - 0.61
		Popov et al 1952		4 - 6.5	1.5 - 2.5
		Amdur et al 1953		2.6 - 21	0.99 - 8.0
		Dubrovskaya 1957		2.6 - 3.0	0.99 - 1.1
		Beck 1959		1.3 - 2.6	0.50 - 0.99
		Henschler et al 1960	d	1.3 - 2.6	0.50 - 0.99
		Bushtueva 1960		1.5	0.57
		Bushtueva 1962		1.6 - 2.6	0.61 - 0.99
		Makhinya 1966		0.87 - 0.88	**0.33 - 0.34**
		Shalamberidze 1967		1.6	0.61
		Leonardos et al 1969	r	1.2	0.46
		Nagata 2003	d	2.3	0.88
		Kleinbeck et al 2011		1.434 - 8.307	0.547 - 3.17
269	**Sulfur Hexafluoride**	Laffort 1968a		24,000,000	4,017,527

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
270	**Sulfuric Acid**	Melekhina 1968	d	0.6	0.15
271	**1,1,2,2 - Tetrabromo-ethane**	Hollingsworth et al 1963	r	<14	<0.99
272	**1,1,2,2 - Tetrachloro-ethane**	Lehmann & Schmidt - Kehl 1936		20	2.9
		Dravnieks & Laffort 1972		1.6	**0.233**
		Dravnieks 1974	d	50	7.3
273	**Tetrahydrofuran**	May 1966	d	90	30.5
		May 1966	r	180	61
		Popov 1970		0.27	**0.092**
		Kendall et al 1968	r	7.3 - 10.2	2.5 - 3.5
		Nagy 1991	d	18	6.1
274	**Thioglycolic Acid**	Dravnieks et al 1986	d	0.0008	0.00021
275	**Toluene**	Backman 1917	r	3.5 - 3.6	0.93 - 0.96
		Backman 1918		2	0.53
		Grijns 1919		170	45
		Zwaardemaker 1927		170	45
		Zwaardemaker 1927		2	0.53
		Schley 1934	d	6	1.6
		Schley 1934	r	16	4.2
		Nader 1958	d	0.08 - 1.9	0.021 - 0.50
		Deadman & Prigg 1959	d	5.5	1.5
		Naus 1962	d	2	0.53
		Stalker 1963	d	1	0.27
		Gusev 1965		1.5 - 3.2	0.40 - 0.85
		May 1966	d	140	37
		May 1966	r	260	69
		Leonardos et al 1969	r	8.1 - 17.8	2.1 - 4.7
		Dravnieks & O'Donnell 1971		45	12
		Koster 1971	d	13.7	3.6
		Dravnieks & Laffort 1972		0.53	0.14
		Artho & Koch 1973		100 - 1,000	26.5 - 265
		Hellman & Small 1973a,b, 1974	d	0.6	0.16
		Hellman & Small 1973a,b, 1974	r	7	1.9
		Dravnieks 1974	d	60	16
		Winneke & Kastka 1975		46 - 84	12 - 22
		Anon. 1980	d	3.5	0.93
		Anon. 1980	r	18	4.8
		Naus 1982	d	2	0.53
		Naus 1982	r	20	5.3
		Punter 1983	d	25.4	6.7
		Bahmuller 1983		5.85 - 29.8	1.55 - 7.9

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
275	**Toluene cont.**	Don 1986	d	3.7 - 3.8	0.98 - 1.01
		Hoshika et al 1993	d	3.7 - 3.8	0.98 - 1.01
		Scharfenberger 1990		17	4.51
		Nagy 1991	d	12	3.18
		Cometto - Muniz 1993	d	590	157
		Cometto - Muniz & Cain 1994	d	590	157
		Hoshika et al 1993	d	305	81
		Cometto - Muniz et al 2002		0.4	0.11
		Cometto - Muniz et al 2003		0.098	**0.026**
		Nagata 2003	d	1.3	0.35
		Cometto - Muniz et al 2004	d	0.12 - 0.38	0.032 - 0.10
		Cometto - Muniz & Abraham 2009b	d	0.3	0.08
276	**Toluene 2,4 - & 2,6 - Diisocyanate**	Zapp 1957		2.8	0.39
		Henschler et al 1962		0.14 - 0.35	**0.020** - 0.049
		Chizhikov 1963		0.2	0.028
		Leonardos et al 1969	r	15	2
277	**o - Toluidine**	Huijer 1924	d	29	6.6
		Backman 1917	r	4.0 - 5.4	0.91 - 1.23
		Stuiver 1958	d	0.11	**0.025**
278	**m - Toluidine**	Huijer 1924	d	26	5.9
		Backman 1917	r	3.0 - 3.9	0.68 - 0.089
		Stuiver 1958	d	2	**0.46**
279	**p - Toluidine**	Huijer 1924	d	14	3.2
		Backman 1917	r	1.0 - 1.3	0.23 - 0.30
		Stuiver 1958	d	0.12	**0.027**
280	**Trichloroacetic Acid**	Backman 1917	r	1.6 - 2.5	**0.24** - 0.37
281	**1,2,4 - Trichlorobenzene**	Rowe 1975		22	2.96
282	**Trichloroethylene**	Lehmann & Schmidt - Kehl 1936		900	167
		Weitbrecht 1957		110	20
		Scherberger et al 1958	r	410	76
		Frantikova 1962		69	13
		Naus 1962	d	3	0.56
		May 1966	d	440	82
		May 1966	r	580	108
		Malyarova 1967		2.5 - 21	**0.5** - 4
		Leonardos et al 1969	r	115	21
		Torkelson & Rowe 1981		538	100
		Naus 1982	d	3	0.56
		Naus 1982	r	20	3.72
		Don 1986	d	3.9	0.73
		Nagata 2003	d	21	3.91

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
283	**Trichlorofluoromethane**	Hellman & Small 1974	d	28	**5**
		Hellman & Small 1974	r	760	135
		Braker & Mossman 1980		1,124,000	200,057
284	**Triethanolamine**	Nagata 2003	d	>61	>10
285	**Triethylamine**	Tkachev 1970		0.33	0.08
		Hellman & Small 1974	d	<0.4	<0.10
		Hellman & Small 1974	r	1.1	0.27
		Laing et al 1978	r	11.9	2.9
		Homans et al 1978	d	2.7	0.65
		Dravnieks et al 1986	d	1	0.24
		Nagata 2003	d	0.022	**0.0053**
286	**Trimethylamine**	Tempelaar 1913	d	2.1	0.87
		Rotenberg & Mashbits 1967		2	0.83
		Sakuma et al 1967		0.0007	0.00029
		Leonardos et al 1969	r	0.0005	0.00021
		Stephens 1971		0.0014	0.00058
		Amoore 1977		0.0025	0.001
		Bedborough & Trott 1979	d	0.0012	0.0005
		Anon. 1980	d	0.00026	0.00011
		Anon. 1980	r	0.0034	0.0014
		Jensen & Flyger 1983		0.0031 - 0.027	0.00128 - 0.1117
		Langenhove & Schamp 1984		0.002	0.00083
		Homans 1984		4.4	1.82
		Nagy 1991		0.0059	0.0024
		Greenman et al 2004		0.000041 - 0.0011	**0.00002** - 0.00045
		Nagata 2003		0.000077	0.000032
		Van Thriel et al 2006		0.63	0.26
287	**Trimethyl Benzene, all isomers**	Backman 1917	r	0.35 - 0.4	0.071 - 0.081
		Backman 1917	r	0.3 - 0.35	0.061 - 0.071
		Backman 1918		0.2	0.041
		Deadman & Prigg 1959	d	0.7	0.14
		Deadman & Prigg 1959	d	0.2	0.041
		Dravnieks & Laffort 1972		0.03	**0.006**
		Knuth 1973		1.2	0.24
		Dravnieks 1974	d	12	2.4
		Anon. 1980	d	0.14	0.028
		Anon. 1980	r	1.1	0.22
		Anon. 1980	d	0.18	0.037
		Anon. 1980	r	1.4	0.28
		Punter 1983	d	10.7	2.2
		Nagata 2003	d	0.59	0.12
288	**Trimethyl Phosphite**	Levin & Gabriel 1973		0.0005	0.000099

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
289	**Turpentine and selected monoterpenes**	Apell 1969		0.016	0.0029
		Cristoph 1983	r	25 - 29	4.49 - 5.20
		Cristoph 1983	r	35 - 38	6.3 - 6.8
		Randerbrock 1986		0.00036	**0.00006**
		Laska & Hudson 1991	d	0.23 - 0.36	0.041 - 0.065
		Lindell 1991	d	2.1	0.38
		Lindell 1991	d	3.3	0.59
		Lindell 1991	d	8.9	1.60
		Cometto - Muniz et al 1998b	d	105	19
		Cometto - Muniz et al 1998b	d	65	12
		Jagella & Grosch 1998		0.035	0.0063
		Jagella & Grosch 1998		0.018	0.0032
		Cometto - Muniz 1999	d	105	19
		Cometto - Muniz 1999	d	65	12
		Molhave et al 2000	d	23	4.13
		Buettmer & Schieberle 2001a, 2001b		0.0053	0.0010
		Nagata 2003	d	0.18	0.032
		Nagata 2003	d	0.1	0.0179
290	**n - Valeraldehyde**	Backman 1917	r	0.009 - 0.01	0.0026 - 0.0028
		Teranishi et al 1974		0.072	0.02
		Anon. 1980	d	0.0025	0.0007
		Anon. 1980	r	0.013	0.0037
		Hall & Andersson 1983	d	0.034	0.0097
		Cristoph 1983	r	0.14 - 0.15	0.04 - 0.043
		Lindell 1991	d	0.092	0.026
		Von Ronson & Belitz 1992a	d	0.12	0.034
		Von Ronson & Belitz 1992a	r	0.22	0.062
		Cometto - Muniz et al 1998a		17.5	4.97
		Cometto - Muniz 1999	d	17.5	4.97
		Nagata 2003	d	0.0014	**0.0004**
		Laska & Ringh 2010	d	0.85	0.24
291	**Vanillin**	Passy 1892a,b,d	d	0.00007 - 0.005	0.000011 - 0.000803
		Tempelaar 1913	d	0.00018 - 0.0002	0.000029 - 0.000032
		Zwaardemaker 1927	d	0.00018 - 0.0002	0.000029 - 0.000032
		Backman 1917	r	0.0015 - 0.002	0.000241 - 0.000321
		Baldus 1936	d	0.000001	0.00000016
		Baldus 1936	r	0.000004	0.000000643
		Appell 1969		0.000001	**0.00000016**
		Randebrock 1971		0.000006	0.000000964

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
291	**Vanillin cont.**	Herrmann & Abel El Salam 1980a,b		0.08 - 0.12	0.0129 - 0.0193
		Kleinschmidt 1983	r	0.578	0.0929
		Randebrock 1986		0.000033	0.00000530
		Blank et al 1989, 1992		0.0006 - 0.0012	0.000096 - 0.000193
292	**Vinyl Acetate**	Gofmekler 1960		1	0.28
		Deese & Joyner 1969	r	≤1.4	≤0.40
		Hellman & Small 1973a,b, 1974	d	0.4	**0.12**
		Hellman & Small 1973a,b, 1974	r	1.4	0.4
293	**Vinyl Chloride**	Hori et al 1972		520 - 910	203 - 356
294	**Vinylidene Chloride**	Rylova 1953		200	**50**
		Janicek et al 1960		5500	1387
		Irish 1962		2,000 - 4,000	504 - 1,009
295	**Xylene (o - , m - , p - , isomers)**	Backman 1917	r	1.0 - 1.2	0.23 - 0.28
		Backman 1917	r	1.1 - 1.3	0.25 - 0.30
		Backman 1917	r	1.4 - 1.5	0.32 - 0.35
		Backman 1918		0.8	0.18
		Stuiver 1958	d	2.1	0.48
		Stuiver 1958	d	0.35	0.081
		Stuiver 1958	d	0.6	0.14
		Naus 1962	d	1	0.23
		Gusev 1965		0.6 - 1.9	0.14 - 0.44
		May 1966	d	100	23
		May 1966	r	1,370	316
		Koster 1965, 1968a,b, 1971	d	0.6 - 86	0.16 - 20
		Koster 1968a, 1971	d	11	2.5
		Koster 1968a, 1971	d	8	1.8
		Leonardos et al 1969	r	2	0.46
		Dravnieks & O'Donnell 1971		1.3	0.3
		Knuth 1973		0.8	0.18
		Anon. 1980	d	0.77	0.18
		Anon. 1980	r	3.1	0.71
		Anon. 1980	d	0.52	0.12
		Anon. 1980	r	2.4	0.55
		Anon. 1980	d	0.52	0.12
		Anon. 1980	r	2.2	0.51
		Punter 1983	d	23.6	5.4
		Punter 1983	d	1.5 - 4.9	0.35 - 1.1
		Punter 1983	d	9.1	2.1
		Don 1986	d	0.52 - 0.54	0.120 - 0.124

Table 6.3 – Odor Threshold Values, cont. *Bold = Lowest Value Reported*

#	Chemical Name	Source	Type of Threshold	Odor Thresholds	
				mg/m³	ppm
295	**Xylene (o - , m - , p - , isomers) cont.**	Hoshika et al 1993	d	0.52 - 0.54	0.120 - 0.124
		Hoshika et al 1993	d	0.052	**0.012**
		Nagata 2003	d	1.6	0.37
		Nagata 2003	d	0.18	0.041
		Nagata 2003	d	0.25	0.058

Table 6.4 – Odor Character List

The Table contains the following information:

- Odor Character
- Chemical Name

Note: Odor character is affected by odor concentration.

Table 6.4 – Odor Character List

Odor Character	Chemical(s)
Acetone	Diethyl Ketone; 2-Methylcyclohexanone
Acid	Acetic Anhydride; Cyanogen Chloride; Phenol
Acrid	Maleic Anhydride
Airplane glue	Methyl Acrylate
Alcohol	n-Butyl Alcohol; sec-Butyl Alcohol; tert-Butyl Alcohol; 1,4-Dioxane; Ethyl Acrylate, Ethyl Alcohol; Ethyl Silicate; Furfuryl Alcohol; Isobutyl Alcohol; 2-Methoxyethanol; Methyl Alcohol; Propyl Alcohol
Alliaceous	Bromine; Iodine
Almond	Acetophenone; Benzaldehyde; Chlorobenzene; Cyanogen; Furfural; Hydrogen Cyanide; Nitrobenzene
Amine	Dibutylamine; Diethanolamine; Diethylamine; 2-Diethylaminoethanol; Diisopropylamine; Isopropylamine; n-Methyl-2-Pyrrolidone; Morpholine; o-Toluidine; p-Toluidine; Triethyleamine
Ammonia; Ammonical	n-Butylamine; Cyclohexylamine; Diethanolamine; Diethylaminoethanol; n,n-Dimethylacetamide; Dimethylamine; Ethanolamine; Ethyl Acrylate; Ethylamine; Ethylenediamine; Ethyleneimine; n-Ethylmorpholine; Hydrazine; Isopropylamine; 1-Methoxy-2-Propanol; Methyl Hydrazine; Triethanolamine
Anesthetic	Ethyl Ether; Methyl tert-Butyl Ether
Anise	Benzyl Acetate
Aromatic	Benzene; 1,3-Butadiene; Carbon Tetrachloride; Chlorotoluene; 1,1-Dichloroethane; Ethyl Formate; Isoprene; Propylene; o-Toluidine; 1,2,4-Trichlorobenzene; Trimethyl Benzene
Asparagus	Dimethyl Disulfide; Dimethyl Sulfide
Banana	n-Amyl Acetate; n-Butyl Acetate; sec-Hexyl Acetate; Isoamyl Acetate
Bitter	Isoamyl Alcohol
Bitter almond	Benzaldehyde
Bleach	Chlorine; Nitrogen Dioxide
Bread	Furfural
Burnt	Pyridine, Toluene
Burnt plastic	Cresol
Butter-like; buttery	Biphenyl; Diacetyl
Camphor; camphorous	Camphor; Cyclohexanol; o-Dichlorobenzene; p-Dichlorobenzene; 1,1,2,2-Tetrabromoethane; Turpentine
Caramel	Vanillin
Chemical	Iodoform

Table 6.4 – Odor Character List, cont.

Odor Character	Chemical(s)
Chlorine	Chlorine Dioxide; Chloropicrin
Chloroform	Bromoform; 1,1-Dichlrorethane; Epichlorohydrin; Halothane; Vinylidene Chloride
Choking	Phthalic Anhydride
Citrus	Citral; d-Limonene
Creosote	Cresol; Naphthalene; Phenol
Decayed	n-Valeraldehyde
Disagreeable	Diallylamine; Dimethyl Sulfide; Propylene Glycol Dinitrate
Dry cleaner	Carbon Tetrachloride
Empyreumatic	Aniline; Benzene; Cresol; Naphthalene; Phenol; o-Toluidine; m-Toluidine; p-Toluidine; Xylene
Ester	2-Butoxyethanol, 2-Ethoxyethyl Acetate; Ethyl Acrylate; Isobutyl Acetate; 2-Methoxyethyl Acetate; n-Propyl Acetate
Ether; Etherish; Etherous; Ethereal	Acetone; Acetonitrile; n-Amyl Acetate; Benzyl Acetate; Carbon Tetrachloride; Chlorodifluoromethane; Chloroform; Dichlorodifluoromethane; Dimethyl Ether; Ethyl Acetate; Ethyl Bromide; Ethylene Chlorohydrin; Ethyl Ether; Furfuryl Alcohol; Iodoform; 1-Methoxy-2-propanol; Methyl Chloride; Methyl Chloroform; Methyl Formate; Perchloroethylene; Tetrahydrofuran; Trichloroethylene
Faint	n-Nitrosodimethylamine
Fingernail polish	Ethyl Acetate; Methyl Propyl Ketone
Fingernail polish remover	Diethyl Ketone
Fir needles	Turpentine
Fish sauce	2,4-Dichlorophenol
Fishy	Diethylamine; Diisopropylamine; Dimethyl Formamide; 1,1-Dimethylhydrazine; Methylamine; Morpholine; Triethylamine; Trimethylamine
Floral; Flowery	Citral; Diphenylamine
Fresh	Acetaldehyde; Isoamyl Acetate
Fruity	Acetaldehyde; Acetone; Benzaldehyde; 2-Butoxyethyl Acetate; sec-Butyl Acetate; 2-Chloroacetophenone; Cyclopentadiene; Ethyl Acetate; sec-Hexyl Acetate; Isopropyl Acetate; Methyl Acetate; 2-Nitropropane; Propionaldehyde
Fusel	Isobutyl Alcohol
Garlic	Acetylene; Acrylonitrile; Arsine; Dimethyl Disulfide; Hydrogen Selenide; Methyl Mercaptan; Phosphine
Gasoline	p-tert-Butyl Toluene; Heptane; Hexane, Nonane; Octane
Gassy	Acetylene; Propylene
Grassy	Ethylene; n-Hexyl Alcohol
Green	Acetaldehyde
Hay like	Phosgene
Highly corrosive	Hydrogen Fluoride
Ink	Phenol
Irritating	Allyl Isothiocyanate; Ammonia; Bromine; Cresol; Cumene Hydroiperoxide; 2,3-Dibromo-1-chloropropane; Hydrogen Chloride; Hydrogen Fluoride

Table 6.4 – Odor Character List, cont.

Odor Character	Chemical(s)
Latex	Isobutyl Alcohol
Leather-like	2;4-Dichlorophenol
Lemon	Citral; d-Limonene
Malty	n-Butyl Alcohol; sec-Butyl Alcohol; Isoamyl Alcohol
Medicinal	n-Butyl Alcohol; Carbon Disulfide; 2,4-Dichlorophenol; Isobutyl Acetate; Phenol
Metallic	Sulfur Dioxide
Mild	tert-Butyl Acetate; n- Butyl Lactate; Caprolactam; 2-(2-Ethoxyethoxy)ethanol; Hexylene Glycol; Triethanolamine
Mothballs	p-Dichlorobenzene; Naphthalene
Mushroom	Methyl n-amyl Ketone
Mustard	allyl alcohol
Musty	2-Butoxyethanol; Diethylamine; 2-Ethoxyethanol; Isobutyl Alcohol
Natural gas	Butane; Propane
Nauseating	Pyridine
Oil	Octane
Oily	Aniline; Dimethylaniline; Ethyl Benzene
Olefinic	Ethylene Oxide
Onion	acrylonitrile
Oranges	acetophenone
Paint	Methyl n-Butyl Ketone
Pears	Benzyl Acetate; sec-Hexyl Acetate
Peculiar	Oxygen Difluoride; Quinoline
Penetrating	1-Octanol
Pepper	Piperdine
Peppermint	Diisobutyl Ketone
Petroleum	Butenes; 1-Hexene; Methylcyclohexane
Phenol; phenolic	Cresol; 2;4-Dichlorophenol
Pine	Cyclopentadiene; Turpentine
Plastic	Acrylic Acid; Benzyl Acetate; n-Butyl Acrylate; Ethyl Acrylate; n-Hexyl Alcohol; d-Limonene; Methyl Acrylate; Methyl Metacrylate
Pleasant	Biphenyl; 1-Decene; Diacetyl; 1;2-Dichloroethylene; 2-(2-Ethoxyethoxy)ethanol; Isooctyl Alcohol
Pungent	Acetaldehyde; Acetic Acid; Acetophenone; Acrolein; Ally Chloride; Ammonia; Aniline; Benzyl Chloride; Boron Trifluoride; Butyraldehyde; Crotonaldehyde; Cyclohexane; Decaborane; Ethyl Chloride; Fluorine; Formaldehyde; Hexachlorocyclopentadiene; Isobutyraldehyde; Methacrylic Acid; Methyl Parathion; Methyl Vinyl Ketone; Nitrobenzene; Ozone; Pentaborane; Pyridine; Quinone; 1,1,2,2-Tetrabromoethane; Trimethylamine; Trimethyl Phosphite
Putrid	Dimethyl Disulfide; Dimethyl Sulfide; Phenyl Mercaptan
Rancid	Acrylic Acid; n-Butyl Acrylate; Isoamyl Alcohol; n-Valeraldehyde
Repulsive	Diborane

Table 6.4 – Odor Character List, cont.

Odor Character	Chemical(s)
River water	Acetophenone
Rosiny	Turpentine
Rotten cabbage	Ethyl Mercaptan; Methyl Mercaptan
Rotten eggs	Hydrogen Sulfide
Rotten fish	Diethanolamine; Dimethylamine
Rubber	1;3-Butadiene; Chloroprene; Isoamyl Alcohol; Isobutyl Alcohol; d-Limonene
Rubbing alcohol	Isopropyl Alcohol
Sharp	Bromine; Chlorine; Cumene; Cumene Hydroperoxide; Cyclohexanone; Dicyclopentadiene; 2-Diethylaminoethanol; Ethyl Acrylate; Ethyl Amyl Ketone; Formic Acid; Hydrogen Chloride; Iodine; Isophorone; Isopropyl Alcohol; Methyl Acrylate; Methyl Ethyl Ketone; Methyl Isoamyl Ketone, Methyl Isobutyl Ketone; Methyl Methacrylate; Styrene; Vinyl Acetate
Shoe polish	Chlorobenzene; Nitrobenzene
Sickening	n-Valeraldehyde
Skunk	Butyl Mercaptan; Dodecyl Mercaptan
Smoky	Cresol
Solvent	Benzene; Ethyl Amyl Ketone; Ethyl Benzene; 1,1,2,2-Tetrachloroethane; Trichloroethylene
Sooty	Nickel Carbonyl
Sour	Acetic Anhydride; n-Butylamine; Methyl Alcohol; Propionic Acid; Toluene; Vinyl Acetate
Strong	Furan; Oxygen Difluoride; Picolines
Suffocating	Acetaldehyde; Bromoform; Chlorine; Chloroform; Nitric Acid
Sulfide	Carbon Disulfide
Sweet	Acetone; Acetophenone; Acrylic Acid; Benzene; Bromoform; 2-Butoxyethanol; n-Butyl Acetate; n-Butyl Acrylate; n-Butyl Alcohol; sec-Butyl Alcohol; tert-Butyl Alcohol; Carbon Tetrachloride; Chloroform; Cyclohexanone; Cyclohexene; Diacetone Alcohol; Dicyclopentadiene; 1,4-Dioxane; 2-Ethoxyethanol; 2-Ethoxyethyl Acetate; Ethyl Acetate; Ethyl Acrylate; Ethylene Dibromide; Ethylene Dichloride; Ethylene Oxide; Ethyl Silicate; Furfuryl Alcohol; Hexylene Glycol; Isoamyl Alcohol; Isobutyl Acetate; Isobutyl Alcohol; Isopropyl Ether; Mesityl Oxide; 2-Methoxyethanol; 2-Methoxyethyl Acetate; Methyl Alcohol; Methyl n-amyl Ketone; Methyl n-Butyl Ketone; Methyl Chloride; Methyl Chloroform; Methylene Chloride; Methyl Ethyl Ketone; Methyl Isoamyl Ketone; Methyl Isobutyl Ketone; Pentane; Perchloryl Fluoride; n-Propyl Acetate; Propyl Alcohol; Propylene Dichloride; Propylene Oxide; Styrene; Vanillin; Vinyl Chloride; Xylene
Tar	Naphthalene
Terpene-like; terpeny	Cyclopentadiene; d-Limonene
Thunder storm	Ozone
Turpentine	Ethylidene Norbornene; Turpentine
Unpleasant	Carbonyl Sulfide; Picolines; Thioglycolic Acid
Vanilla	Vanillin
Vegetable	Carbon Disulfide
Vinegar	acetic acid
Vinous	Ethyl Alcohol

Table 6.5 – Synonyms of Chemical Names

The table contains the following information:

- Synonyms in alphabetical order
- Chemical Name

Table 6.5 – Synonyms

Synonym Name	Chemical Name
Acetanhydride	Acetic Anhydride
Acetic Acid Benzyl Ester	Benzyl Acetate
Acetic Acid Dimethylamine	Dimethylamine
Acetic Aldehyde	Acetaldehyde
Acetic Oxide	Acetic Anhydride
Acetoacetone	2,4-Pentanedione
Acetylene Tetrachloride	1,1,2,2-Tetrachloroethane
Acetyl Oxide	Acetic Anhydride
Acroleaic Acid	Acrylic Acid
Acrylic Acid n-butyl Ester	n-Butyl Acrylate
Acrylic Acid Ethyl Ester	Ethyl Acetate
Adronal	Cyclohexanol
Aethyl Chloride	Ethyl Chloride
Aldehyde Crotonique	Crotonaldehyde
Allyl Mustard Oil	Allyl Isothiocyanate
1-Aminobutane	n-Butylamine
Aminocyclohexane	Cyclohexylamine
2-Aminoethanol	Ethanolamine
1-Amino-2-Methylbenzene	o-Toluidine
1-Amino-3-Methylbenzene	m-Toluidine
1-Amino-4-Methylbenzene	p-Toluidine
1-Aminonaphthalene	1-Naphthylamine
2-Aminonaphthalene	2-Naphthylamine
2-Aminopropane	Isopropylamine
2-Aminotoluene	o-Toluidine
4-Aminotoluene	p-Toluidine
3-Aminotoluene	m-Toluidine
n-Amyl Alcohol	Pentanol, all isomers
Amyl Ethyl Ketone	Ethyl Amyl Ketone
1-Benzazine	Quinoline
Benzene Chloride	Chlorobenzene

Synonym Name	Chemical Name
Benzenethiol	Phenyl Mercaptan
Benzinofonn	Carbon Tetrachloride
1,4-Benzoquinone	Quinone
Biethylene	1,3-Butadine
2-Bromo-2-Chloro-1,1,1-Trifluoroethane	Halothane
Butadien	1,3-Butadiene
Butanal	Butyraldehyde
2,3-Butanedione	Diacetyl
1-Butanethiol	Butyl Mercaptan
n-Butanol	n-Butyl Alcohol
2-Butanol	sec-Butyl Alcohol
tert-Butanol	tert-Butyl Alcohol
Butanone	Methyl Ethyl Ketone
2-Butenal	Crotonaldehyde
1-Buten-3-one	Methyl Vinyl Ketone
n-Butyl-1-Butanamine	Dibutylamine
Butyl Cellosolve	2-Butoxyethanol
Butyl Cellosolve Acetate	2-Butoxyethanol Acetate
1-Butylene	Butenes
Butyl 2-Hydroxypropanoate	Butyl Lactate
1-tert-Butyl-2-Methylbenzene	p-tert-Butyl Toluene
Butyl-2-Propenoate	n-Butyl Acrylate
Butyric Alcohol	n-Butyl Alcohol
Carbolic Acid	Phenol
Carbon Bisulfide	Carbon Disulfide
Carbonic Chloride	Phosgene
Carbon Nitride	Cyanogen
Carbonyl Chloride	Phosgene
Cellosolve	2-Ethoxyethanol
Cellosolve Acetate	2-Ethoxyethyl Acetate

Table 6.5 – Synonyms, cont.

Synonym Name	Chemical Name
Chlorene	Ethyl Chloride
Chlorine Cyanide	Cyanogen Chloride
Chloformyl Chloride	Phosgene
3-Chloroally Chloride	1,3-Dichloropropene
Chloroben	Dichlorobenzene, o-isomer
Chlorobenzol	Chlorobenzene
2-Chloro-1 ,3-butadiene	_-Chloroprene
4-Chlorocarbonyl Polystyrene	Benzoyl Chloride
Chlorocyanogen	Cyanogen Chloride
Chloroethane	Ethyl Chloride
2-Chloroethanol	Ethylene Chlorohydrin
Chloroethene	Vinyl Chloride
Chloroethylene	Vinyl Chloride
1-Chloro-2,3-Epoxypropane	Epichlorohydrin
Chloromethane	Methyl Chloride
1-Chloro-2-Methylbenzene	Chlorotoluene, o-isomer
3-Chloro-1-Propene	Allyl Chloride
3-Chloropropylene	Allyl Chloride
_-Chlorotoluene	Benzyl Chloride
Cinnamene	Styrene, monomer
Cresylic Acid	Cresol, all isomers
Cyano Acrylic Acid Methyl Ester	Methyl 2-Cyanoacrylate
Cyanomethane	Acetonitrile
2,5-Cyclohexadiene Dioxide	Quinone
Cyclohexyl Alcohol	Cyclohexanol
DCPD	Dicyclopentadiene
DEAE	2-Diethylaminoethanol
1,2-Diaminoethane	Ethylenediamine
1,2-Dibromoethane	Ethylene Dibromide
1,2-Dichloroethane	Ethylene Dichloride
Dichloromethane	Methylene Chloride
1,2-Dichloropropane	Propylene Dichloride
1,3-Dichloropropylene	1,3-Dichloropropene
Dicyan	Cyanogen
N-Diethylethanolamine	2-Diethylaminoethanol
Diethyl- 2-hydroxyethyl amine	2-Diethylaminoethanol
Diethylene Oxide	Tetrahydrofuran

Synonym Name	Chemical Name
1,4-Diethylene Dioxide	Dioxane
Diethyl Ether	Ethyl Ether
Diethylolamine	Diethanolamine
Difluorochloromethane	Chlorodifluoromethane
2,2-Dihydroxy Diethylamine	Diethanolamine
2,4-Diisocyanato-1-Methylbenzene	Toluene-2,4-Diisocyanate
Dimethyl Acetate	N,N-Dimethylaniline
Dimethyl Benzene	Xylene
1,3-Dimethylbutyl Acetate	sec-Hexyl Acetate
Dimethyl Diketone	Diacetyl
Dimethyl Glyoxal	Diacetyl
Dimethyformaldehyde	Acetone
Dimethylnitromethane	2-Nitropropane
Dimethyl Nitrosamine	N-Nitrosodimethylamine
o,o-Dimethyl, o,p-Nitrophenyl Phosphorothioate	Methyl Parathion
3,7-Dimethyl-2,6-Octadienal	Citral
Dimethyl Oxide	Dimethyl Ether
Diphenyl	Biphenyl
Diphenylmethane 4,4-Diisocyanate	Methylene Bisphenyl Isocyanate
Di-2-Propenylamine	Diallylamine
Divinyl	1,3-Butadiene
DMA	Dimethylamine
DMN	N-Nitrosodimethylamine
DMNA	N-Nitrosodimethylamine
DMF	Dimethyl Formamide
1-Dodecanethiol	Dodecyl Mercaptan
EAK	Ethyl Amyl Ketone
EGBE	2-Butoxyethanol
EGBEA	2-Butoxyethyl Acetate
EgMEA	2-Methoxyethyl Acetate
1,4-Epoxybutane	Tetrahydrofuran
1,2-Epoxy-3-Chloropropane	Epichlorohydrin
2,3-Epoxypropyl Chloride	Epichlorohydrin
1,2-Epoxyethane	Ethylene Oxide
Erythrene	1,3-Butadiene

Table 6.5 – Synonyms, cont.

Synonym Name	Chemical Name
Ethanal	Acetaldehyde
1,2-Ethanediamine	Ethylenediamine
1,2-Ethanediol	Ethylene Glycol
Ethanenitrile	Acetonitrile
Ethanethiol	Ethyl Mercaptan
Ethanoic Acid	Acetic Acid
Ethanol	Ethyl Alcohol
Ethene	Ethylene
Ethenyl Acetate	Vinyl Acetate
Ethenyl Benzene	Styrene
Ethenyl Cyanide	Acrylonitrile
Ethoxyethane	Ethyl Ether
Ethyl Acetone	Methyl Propyl Ketone
Ethylene Bromide	Ethylene Dibromide
Ethylene Carboxylic Acid	Acrylic Acid
Ethylene Chloride	Ethylene Dichloride
Ethylene Glycol Methylene Ether	1,3-Dioxolane
Ethylene Glycol Monobutyl Ether	2-Butoxyethanol
Ethylene Glycol Monoethyl Ether	2-Ethyoxyethanol
Ethylene Glycol Monoethyl Ether Acetate	2-Ethyoxyethyl Acetate
Ethylene Glycol Methyl Ether	2-Methoxyethanol
Ethylene Glycol Monomethyl Acetate	2-Methyoxyethyl Acetate
Ethylethylene	Butenes, all isomers
Ethyl Fonnic Acid	Propionic Acid
Ethyl Glycol	2-Ethoxyethanol
Ethyl Glycol Acetate	2-Ethoxyethyl Acetate
5-Ethlidenebycyclo[2.2.1]-2-Heptene	Ethylidenenorbomene
Ethylidene Chloride	1,1-Dichloroethane
Ethylmethyl Carbinol	sec-Butyl Alcohol
Ethyl Nitrile	Acetonitrile
Ethylolamine Glycol	Ethanolamine
Ethyl 2-Propenoate	Ethyl Acrylate
Ethyne	Acetylene

Synonym Name	Chemical Name
Formic Acid Ethyl Ester	Ethyl Formate
Formic Nitrate	Hydrogen Cyanide
Freon 12	Dichlorodifluoromethane
Freon 22	Chlorodilfluoromethane
Freon 30	Methylene Chloride
Freon 40	Methyl Chloride
2,5-Furandione	Maleic Anhydride
2-Furanmethanol	Furfuryl Alcohol
Glacial Acrylic Acid	Acrylic Acid
Glycinol	Ethanolamine
2-Heptanone	Methyl n-Amyl Ketone
Hexahydroaniline	Cyclohexylamine
Hexahydroazine	Piperidine
Hexahydrobenzene	Cyclohexane
Hexahydrophenol	Cyclohexanol
Hexahydrotoluene	2-Methycyclohexane
Hexalin	Cyclohexanol
Hexamethylene	Cyclohexane
Hexanaphthalene	Cyclohexane
Hexanaphthylene	Cyclohexene
1-Hexanol	Hexyl Alcohol
2-Hexanone	Methyl n-Butyl Ketone
Hexone	Methyl Isobutyl Ketone
Hydroxy Benzene	Phenol
Hydrocyclohexane	Cyclohexanol
1-Hydroxy-2,4-Dichlorobenzene	2,4-Dichlorophenol
2-Hydroxyethyl Chloride	Ethylene Dichloride
4-Hydroxy-4-Methyl-2-Pentanone	Diacetone Alcohol
2,2-Iminodiethanol	Diethanolamine
1,3-Isobenzofurandione	Phthalic Anhydride
Isobutanol	Isobutyl Alcohol
Isobutyl Carbinol	Isoamyl Alcohol
Isocyanic Acid-Methyl Ester	Methyl Isocycanate
Isonitropropane	2-Nitropropane
Isopentyl Acetate	Isoamyl Acetate
Isopentyl Alcohol	Isoamyl Alcohol

Table 6.5 – Synonyms, cont.

Synonym Name	Chemical Name
Isopropanol	Isopropyl Alcohol
Isopropenylbenzene	Methyl Styrene
Isopropenyl Cyanide	Methacrylonitrile
4-Isopropenyl-1-Methyl-1-Cyclohexene	d-Limonene
2-Isopropoxypropane	Isopropyl Ether
Isopropyl Benzene	Cumene
Isopropyl Benzene Hydroperoxide	Cumene Hydroperoxide
Isopropylidene Acetone	Mesityl Oxide
Ketohexamethylene	Cyclohexanone
MBK	Methyl n-Butyl Ketone
MEK	Methyl Ethyl Ketone
Mercaptoacetic Acid	Thioglycolic Acid
Mesitylene	Trimethyl Benzene
Methanal	Formaldehyde
Methanamine	Methylamine
Methanethiol	Methyl Mercaptan
Methanol	Methyl Alcohol
Methanone	Acetaldehyde
Methoxymethane	Dimethyl Ether
Methylacetic Acid	Propionic Acid
Methyl Acetone	Methyl Ether Ketone
_-Methylacrolein	Crotonaldehyde
2-Methylaniline	o-Toluidine
3-Methylaniline	m-Toluidine
4-Methylaniline	p-Toluidine
Methyl-2-Butanone	Methyl Isopropyl Ketone
2-Methylbenzeneamine	o-Toluidine
3-Methylbenzenamine	m-Toluidine
4-Methylbenzenamine	p-Toluidine
Methylbenzene	Toluene
3-Methyl-1-butanol	Isoamyl Alcohol
3-Methyl-1-butanol Acetate	Isoamyl Acetate
3-Methyl-2-butanone	Methyl Isopropyl Ketone
Methyl Cellosolve	2-Methoxyethanol
Methyl Cyanide	Acetonitrite
Methyl Dithiomethane	Dimethyl Disulfide

Synonym Name	Chemical Name
Methyl Glycol	2-Methoxyethanol
2-Methyl-1-Heptanol	Isooctyl Alcohol
5-Methyl-3-Heptanone	Ethyl Amyl Ketone
5-Methyl-3-Hexanone	Methyl Isoamyl Ketone
Methyl Isoamyl Acetate	sec-Hexyl Acetate
N-Methylmethanamine	Dimethylamine
Methyl 2-Methyl-2-Propenoate	Methyl Methacrylate
N-Methyl-N-Nitrosomethanamine	N-Nitrosodimethylamine
Methyloxidrane	Propylene Oxide
2-Methyl-2,4-Pentanediol	Hexylene Glycol
4-Methyl-2-Pentanone	Methyl Isobutyl Ketone
4-methyl-3-Pentene-2-One	Mesityl Oxide
4-Methylpentyl-2-Acetate	sec-Hexyl Acetate
Methylphenol	Cresol, all isomers
4-Methyl-1,3-Phenylenediisocyanate	Toluene-2,4- or 2,6-Diisocyanate
Methyl 2-Propenoate	Methyl Acrylate
2-Methylpropenoic Acid	Methacrylic Acid
1-Methyl Propanol	sec-Butyl Alcohol
2-Methyl-1-Propanol	Isobutyl Alcohol
2-Methyl-2-Propanol	tert-Butyl Alcohol
2-Methyl-2-Propenitrile	Methacrylonitrile
2-Methylpropyl Acetate	Isobutyl Acetate
2-Methylpyridine	Picolines
MIBK	Methyl Isobutyl Ketone
MIC	Methyl Isocyanate
MIPK	Methyl Isopropyl Ketone
Monochlorobenzene	Chlorobenzene
Monoethyl Ether of Ethylene Glycol	2-Ethoxyethanol
Necatorina	Carbon Tetrachloride
Nitro	Methyl Parathion
Nitrox	Methyl Parathion
1-NP	1-Nitropropane
2-NP	2-Nitropropane
3-Octanone	Ethyl Amyl Ketone
Orthodichloro Benzene	Dichlorobenzene, o-isomer

Table 6.5 – Synonyms, cont.

Synonym Name	Chemical Name
Oxacyclopentadiene	Furan
Oxirane	Ethylene Oxide
2-Oxobutane	Methyl Ethyl Ketone
Oxocyclohexane	Cyclohexanone
Oxybenzene	Phenol
Oxybismethane	Dimethyl Ether
PAN	Phthalic Anhydride
Parazene	Dichlorobenzene, p-isomer
Paracide	Dichlorobenzene, p-isomer
Parton M	Methyl Parathion
Pentanal	n-Valeraldehyde
1,5-Pentanedial	Glutaraldehyde
1-Pentanol	Amyl Alcohol
2-Pentanone	Methyl Propyl Ketone
3-Pentanone	Diethyl Ketone
Pentyl Acetate	n-Amyl Acetate
Perchlorocyclopentadiene	Hexachloro-1.3-Cyclopentadiene
Perchloromethane	Carbon Tetrachloride
PGDN	Propylene Glycol Dinitrate
Phenacyl Chloride	2-Chloracetophenone
Phenyl Benzene	Biphenyl
N-Phenylbenzene Amine	Diphenylamine
Phenyl Chloride	Chlorobenzene
Phenyl Ethane	Ethyl Benzene
Phenyl Ethylene	Styrene, Monomer
Phenyl Hydroxide	Phenol
Phenylic Acid	Phenol
Phenylmethane	Toluene
Phenylmethyl Acetate	Benzyl Acetate
2-Phenyl-1-Propane	Methyl Styrene
Phosphorothiol	Methyl Parathion
Propanal	Propionaldehyde
2-Propanamine	Isopropylamine
1,2-Propanediol	Propylene Glycol
1,2-Propanediol Dinitrate	Propylene Glycol Dinitrate
Propane Nitrile	Acrylonitrile
Propane Oxide	Propylene Oxide

Synonym Name	Chemical Name
Propanoic Acid	Propionic Acid
1-Propanol	Propyl Alcohol
2-Propanol	Isopropyl Alcohol
2-Propanone	Acetone
2-Propenal	Acrolein
Propene	Propylene
Propene Acid	Acrylic Acid
Propenenitrile	Acrylonitrile
Propene Oxide	Propylene Oxide
Propenoic Acid	Acrylic Acid
2-Propenoic Acid	Acrylic Acid
2-Propenoic Acid Butyl Ester	n-Butyl Acrylate
2-Propen-1-ol	Allyl Alcohol
1-Propenol-3	Allyl Alcohol
2-Propenyl Isothiocyanate	Allyl Isothiocyanate
Propional	Propionaldehyde
2-Propylamine	Isopropylamine
Propylene Chloride	N,N-Dimehtylacetamide
Santochlor	Dichlorobenzene, p-isomer
Silicic Acid Tetraethyl Ester	Ethyl Silicate
TCE	Trichloroethylene
Termitkiln	Dichlorobenzene, o-isomer
sym-Tetrachlorethane	1,1,2,2-Tetrachlorethane
Tetrachloroethene	Perchloroethylene
Tetrachloroethylene	Perchloroethylene
Tetrachloromethane	Carbon Tetrachloride
3a,4,7,7a-Tetrahydro-4,7-Methanoindene	Dicyclopentadiene
Tetramethylene Oxide	Tetrahydrofuran
THF	Tetrahydrofuran
Thiophenol	Phenyl Mercaptan
TMA	Trimethylamine
Toluol	Toluene
Tribromoethane	Bromoform
1,1,1-Trichloroethane	Methyl Chloroform
Triiodomethane	Iodoform
1,7-Trimethylbicyclo[2.2.1]-2-Heptanone	Camphor

Table 6.5 – Synonyms, cont.

Synonym Name	Chemical Name
3,5,5-Trimethyl-2-Cyclohexenone	Isophorone
Trioxychlorofluoride	Perchloryl Fluoride
Vinyl Benzene	Styrene, monomer
Vinyl Carbinol	Allyl Alcohol
Vinyl Cyanide	Acrylonitrile
Vinyl Formic Acid	Acrylic Acid
Wofatos	Methyl Parathion

Table 6.6 – Chemical Abstract Numbers & Chemical Names

The table contains the following information:

- Chemical Abstract Number (CAS) in numerical order
- Chemical Name

Table 6.6 – Chemical Abstract Numbers

CAS #	Chemical Name
50-00-0	Formaldehyde
54-11-5	Nicotine
56-23-5	Carbon Tetrachloride
57-06-7	Allyl Isothiocyanate
57-14-7	1,1-Dimethylhydrazine
57-55-6	Propylene Glycol
60-24-2	Mercaptoethanol
60-29-7	Ethyl Ether
60-34-4	Methyl Hydrazine
62-53-3	Aniline
62-75-9	N-Nitrosodimethylamine
64-17-5	Ethyl Alcohol
64-18-6	Formic Acid
64-19-7	Acetic Acid
67-56-1	Methyl Alcohol
67-63-0	Isopropyl Alcohol
67-64-1	Acetone
67-66-3	Chloroform
68-11-1	Thiogylcolic Acid
68-12-2	Dimethyl Formamide
71-23-8	Propyl Alcohol
71-36-3	n-Butyl Alcohol
71-41-0	Pentanol, all isomers
71-43-2	Benzene
71-55-6	Methyl Chloroform
74-82-8	Methane
74-84-0	Ethane
74-85-1	Ethylene
74-86-2	Acetylene
74-87-3	Methyl Chloride
74-89-5	Methylamine

CAS #	Chemical Name
74-90-8	Hydrogen Cyanide
74-93-1	Methyl Mercaptan
74-96-4	Ethyl Bromide
74-98-6	Propane
75-00-3	Ethyl Chloride
75-01-4	Vinyl Chloride
75-04-7	Ethylamine
75-05-8	Acetonitrile
75-07-0	Acetaldehyde
75-08-1	Ethyl Mercaptan
75-09-2	Methylene Chloride
75-15-0	Carbon Disulfide
75-18-3	Dimethyl Sulfide
75-21-8	Ethylene Oxide
75-25-2	Bromoform
75-28-5	Butane, all isomers
75-31-0	Isopropylamine
75-34-3	1,1-Dichloroethane
75-35-4	Vinylidene chloride
75-44-5	Phosgene
75-45-6	Chlorodifluoromethane
75-47-8	Iodoform
75-50-3	Trimethylamine
75-52-5	Nitromethane
75-56-9	Propylene Oxide
75-65-0	tert-Butyl Alcohol
75-69-4	Trichlorofluoromethane
75-71-8	Dichlorodifluoromethane
75-83-2	Hexane, all isomers except n-hexane
75-85-4	Pentanol, all isomers
76-03-9	Trichloroacetic acid

Table 6.6 – Chemical Abstract Numbers, cont.

CAS #	Chemical Name
76-06-2	Chloropicrin
76-22-2	Camphor, synthetic
77-47-4	Hexachlorocyclopentadiene
77-73-6	Dicyclopentadiene
78-10-4	Ethyl Silicate
78-59-1	Isophorone
78-78-4	Pentane, all isomers
78-79-5	Isoprene
78-83-1	Isobutyl Alcohol
78-84-2	Isobutyraldehyde
78-87-5	Propylene Dichloride
78-92-2	sec-Butyl Alcohol
78-93-3	Methyl Ethyl Ketone
78-94-4	Methyl Vinyl Ketone
79-01-6	Trichloroethylene
79-09-4	Propionic Acid
79-10-7	Acrylic Acid
79-11-8	Monochloroacetic Acid
79-20-9	Methyl Acetate
79-27-6	1,1,2,2-Tetrabromoethane
79-29-8	Hexane, all isomers except n-hexane
79-34-5	1,1,2,2-Tetrachloroethane
79-41-4	Methacrylic acid
79-43-6	Dichloroacetic Acid
79-46-9	2-Nitropropane
80-15-9	Cumene Hydroperoxide
80-56-8	Turpentine & selected monoterpenes
80-62-6	Methyl Methacrylate
84-66-2	Diethyl Phthalate
84-74-2	Dibutyl Phthalate
85-44-9	Phthalic Anhydride
91-08-7	Toluene Diisocyanate
91-20-3	Naphthalene
91-22-5	Quinoline
91-57-6	2-Methylnaphthalene
91-59-8	2-Naphthylamine
92-52-4	Biphenyl

CAS #	Chemical Name
93-82-8	Cumene
95-13-6	Indene
95-47-6	Xylene (o-, m-, p- isomers)
95-48-7	Cresol, all isomers
95-49-8	Chlorotoluene, o-isomer
95-50-1	Dichlorobenzene, o- isomer
95-53-4	o-Toluidine
95-63-6	Trimethyl Benzene, all isomers
96-12-8	2,3-Dibromo-1-Chloropropane
96-14-0	Hexane, all isomers except n-hexane
96-22-0	Diethyl Ketone
96-33-3	Methyl Acrylate
96-37-7	Hexane, all isomers except n-hexane
98-00-0	Furfuryl Alcohol
98-01-1	Furfural
98-51-1	p-tert-Butyl toluene
98-82-8	Cumene
98-83-9	Methyl Styrene
98-86-2	Acetophenone
98-88-4	Benzoyl Chloride
98-95-3	Nitrobenzene
100-37-8	2-Diethylaminoethanol
100-41-4	Ethyl Benzene
100-42-5	Styrene, monomer
100-44-7	Benzyl Chloride
100-52-7	Benzaldehyde
100-61-8	N-Methyl Aniline
100-74-3	N-Ethylmorpholine
101-68-8	Methylene Bisphenyl Isocyanate
102-71-6	Triethanolamine
105-05-5	Diethylbenzenes, mixed isomers
105-46-4	sec-Butyl Acetate
105-60-2	Caprolactam
106-42-3	Xylene (o-, m-, p- isomers)
106-44-5	Cresol, all isomers
106-46-7	Dichlorobenzene, p-isomer
106-49-0	p-Toluidine

Table 6.6 – Chemical Abstract Numbers, cont.

CAS #	Chemical Name
106-51-4	Quinone
106-89-8	Epichlorohydrin
106-93-4	Ethylene Dibromide
106-97-8	Butane, all isomers
106-98-9	Butenes, all isomers
106-99-0	1,3-Butadiene
107-01-7	Butenes, all isomers
107-02-8	Acrolein
107-05-1	Allyl Chloride
107-06-2	Ethylene Dichloride
107-07-3	Ethylene Chlorohydrin
107-13-1	Acrylonitrile
107-15-3	Ethylenediamine
107-18-6	Allyl Alcohol
107-21-1	Ethylene Glycol
107-31-3	Methyl Formate
107-41-5	Hexylene glycol
107-83-5	Hexane, all isomers except n-hexane
107-87-9	Methyl Propyl Ketone
107-98-2	1-Methyoxy-2-Propanol
108-03-2	1-Nitropropane
108-05-4	Vinyl Acetate
108-08-7	Heptane, all isomers
108-10-1	Methyl Isobutyl Ketone
108-11-2	4-Methyl-2-Pentanol
108-18-9	Diisopropylamine
108-20-3	Isopropyl Ether
108-21-4	Isopropyl Acetate
108-24-7	Acetic Anhydride
108-31-6	Maleic Anhydride
108-38-3	Xylene (o-, m-, p- isomers)
108-39-4	Cresol, all isomers
108-44-1	m-Toluidine
108-65-6	1-Methoxy-2-Propyl Acetate
108-67-8	Trimethyl Benzene, all isomers
108-83-8	Diisobutyl Ketone
108-84-9	sec-Hexyl Acetate

CAS #	Chemical Name
108-87-2	Methylcyclohexane
108-88-3	Toluene
108-89-4	Picolines
108-90-7	Chlorobenzene
108-91-8	Cyclohexylamine
108-93-0	Cyclohexanol
108-94-1	Cyclohexanone
108-95-2	Phenol
108-98-5	Phenyl Mercaptan
108-99-6	Picolines
109-06-8	Picolines
109-60-4	n-Propyl Acetate
109-66-0	Pentane, all isomers
109-73-9	n-Butylamine
109-79-5	Butyl Mercaptan
109-86-4	2·Methoxyethanol
109-89-7	Diethylamine
109-94-4	Ethyl Formate
109-99-9	Tetrahydrofuran
110-00-9	Furan
110-12-3	Methyl Isoamyl Ketone
110-19-0	Isobutyl Acetate
110-43-0	Methyl n-amyl Ketone
110-49-6	2·Methoxyethyl Acetate
110-54-3	n-Hexane
110-62-3	n-Valeraldehyde
110-80-5	2-Ethoxyethanol
110-82-7	Cyclohexane
110-83-8	Cyclohexene
110-86-1	Pyridine
110-89-4	Piperdine
110-91-8	Morpholine
111-15-9	2-Ethoxyethyl Acetate
111-27-3	n-Hexyl Alcohol
111-30-8	Glutaraldehyde
111-42-2	Diethanolamine
111-65-9	Octane, all isomers

Table 6.6 – Chemical Abstract Numbers, cont.

CAS #	Chemical Name
111-66-0	1-Octene
111-76-2	2-Butoxyethanol
111-84-2	Nonane
111-87-5	1-Octanol
111-90-0	2-(2-Ethoxyethoxy)ethanol
111-92-2	Dibutylamine
112-07-2	2-Butoxyethyl Acetate
112-55-0	Dodecyl Mercaptan
115-07-1	Propylene
115-10-6	Dimethyl Ether
115-11-7	Butenes, all isomers
120-82-1	1,2,4-Trichlorobenzene
120-83-2	2,4-Dichlorophenol
121-33-5	Vanillin
121-44-8	Triethylamine
121-45-9	Trimethyl Phosphite
121-69-7	Dimethylaniline
122-39-4	Diphenylamine
123-38-6	Propionaldehyde
123-42-2	Diacetone Alcohol
123-51-3	Isoamyl Alcohol
123-54-6	2,4-Pentanedione
123-72-8	Butyraldehyde
123-73-9	Crotonaldehyde
123-86-4	n-Butyl Acetate
123-91-1	1,4-Dioxane
123-92-2	Isoamyl Acetate
124-02-7	Diallylamine
124-09-4	1,6-Hexanediamine
124-38-9	Carbon Dioxide
124-40-3	Dimethylamine
126-98-7	Methacrylonitrile
126-99-8	b-Chloroprene
127-18-4	Perchloroethylene
127-19-5	N,N-Dimethylacetamide
127-91-3	Turpentine & selected monoterpenes
134-32-7	1-Naphthylamine & selected monoterpenes

CAS #	Chemical Name
135-01-3	Diethylbenzenes, mixed isomers
137-05-3	Methyl 2-Cyanoacrylate
137-32-6	Pentanol, all isomers
138-22-7	n-Butyl lactate
138-86-3	d-Limonene
140-11-4	Benzyl Acetate
140-88-5	Ethyl Acrylate
141-32-2	n-Butyl Acrylate
141-43-5	Ethanolamine
141-78-6	Ethyl Acetate
141-79-7	Mesityl Oxide
141-93-5	Diethylbenzenes, mixed isomers
142-82-5	Heptane, all isomers
151-56-4	Ethyleneimine
151-67-7	Halothane
156-59-2	1,2-Dichloroethylene, all isomers
156-60-5	1,2-Dichloroethylene, all isomers
298-00-0	Methyl Parathion
302-01-2	Hydrazine
431-03-8	Diacetyl
460-19-5	Cyanogen
463-58-1	Carbonyl Sulfide
463-82-1	Pentane, all isomers
506-77-4	Cyanogen Chloride
526-73-8	Trimethyl Benzene, all isomers
532-27-4	2-Chloroacetophenone
534-52-1	4,6-Dinitro-o-Cresol
540-59-0	1,2-Dichloroethylene, all isomers
540-84-1	Octane, all isomers
540-88-5	tert-Butyl Acetate
541-85-5	Ethyl Amyl Ketone
542-75-6	1,3-Dichloropropene
542-92-7	Cyclopentadiene
563-80-4	Methyl Isopropyl Ketone
565-59-3	Heptane, all isomers
583-60-8	2-Methylcyclohexanone
584-84-9	Toluene 2,4- or 2,6-Diisocyanate

Table 6.6 – Chemical Abstract Numbers, cont.

CAS #	Chemical Name
589-34-4	Heptane, all isomers
590-18-1	Butenes, all isomers
590-35-2	Heptane, all isomers
591-76-4	Heptane, all isomers
591-78-6	Methyl n-Butyl Ketone
592-41-6	1-Hexene
624-41-9	2-Methyl Butyl Acetate
624-64-6	Butenes, all isomers
624-83-9	Methyl Isocyanate
624-92-0	Dimethyl Disulfide
628-63-7	n-Amyl Acetate
646-06-0	1,3-Dioxolane
822-06-0	1,6-Diisocyanatohexane
872-05-9	1-Decene
872-50-4	n-Methyl-2-Pyrrolidone
1319-77-3	Cresol, all isomers
1330-20-7	Xylene (o-,m-, p- isomers)
1634-04-4	Methyl tert-Butyl Ether
2551-62-4	Sulfur Hexafluoride
4170-30-3	Crotonaldehyde
5392-40-5	Citral
6032-29-7	Pentanol, all isomers
6423-43-4	Propylene Glycol Dinitrate
7446-09-5	Sulfur Dioxide
7553-56-2	Iodine
7616-94-6	Perchloryl Fluoride
7637-07-2	Boron Trifluoride
7647-01-0	Hydrogen Chloride
7664-39-3	Hydrogen Fluoride
7664-41-7	Ammonia
7664-93-9	Sulfuric Acid
7697-37-2	Nitric Acid
7726-95-6	Bromine
7782-41-4	Fluorine
7782-50-5	Chlorine
7783-06-4	Hydrogen Sulfide
7783-07-5	Hydrogen Selenide

CAS #	Chemical Name
7783-41-7	Oxygen Difluoride
7784-42-1	Arsine
7785-26-4	Turpentine & selected monoterpenes
7785-70-8	Turpentine & selected monoterpenes
7803-51-2	Phosphine
8006-64-2	Turpentine & selected monoterpenes
8014-95-7	Sulfuric Acid
10028-15-6	Ozone
10049-04-4	Chlorine Dioxide
10102-44-0	Nitrogen Dioxide
13463-39-3	Nickel Carbonyl
13466-78-9	Turpentine & selected monoterpenes
16219-75-3	Ethylidene Norbornene
17702-41-9	Decaborane
19287-45-7	Diborane
19624-22-7	Pentaborane
25167-67-3	Butenes, all isomers
25340-17-4	Diethylbenzenes, mixed isomers
25551-13-7	Trimethyl Benzene, all isomers
26952-21-6	Isooctyl Alcohol
60435-70-3	Isooctyl Alcohol
86290-81-5	Octane, all isomers

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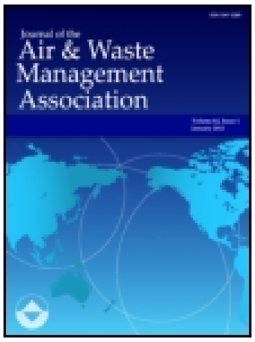

Journal of the Air & Waste Management Association

ISSN: 1096-2247 (Print) 2162-2906 (Online) Journal homepage: https://www.tandfonline.com/loi/uawm20

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TECHNICAL PAPER

Industrial odor sources and air pollutant concentrations in Globeville, a Denver, Colorado neighborhood

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An odor of unknown origin described as a "tar" or "asphalt" smell has become unbearable for many of Globeville, CO, residents over the past few years. Residents report during odor events burning eyes and throat, headaches, skin irritation, and problems sleeping. This study was undertaken to identify the potential sources of the odor and the concentrations of air pollutants making up the odor by conducting meteorological correlations and sampling for a panel of volatile organic compounds (VOCs), sulfur gases, and polycyclic aromatic hydrocarbons (PAHs) in the neighborhood and near suspected sources. Wind speed and direction data collected every 1 min in the neighborhood indicate that when the odor is noticed, the community is directly downwind of a wood preservation facility and an asphalt roofing facility. Air samples collected during high-intensity odor events have shown concentrations of methylene chloride, hexane, toluene, naphthalene, dibenz[a,h]anthracene, benzo[g,h,i]perylene, and indeno[1,2,3-cd]pyrene, each at least two times higher than background concentrations. Naphthalene and the other PAHs are known pollutants emitted from wood treatment processes, and are known to have a coal tar odor. Naphthalene was present in a sample collected directly adjacent to the Koppers facility and was not present in any background samples. Single-compound odor and health thresholds, however, were never surpassed. Given the technical and regulatory challenges of sampling odors and controlling emissions, it is recommended that Globeville residents and neighboring industry pursue a "good neighbor policy" to solve the odor issue. Specific offending industrial processes could be identified for which there exist cost-effective control technologies that would reduce exposure to odors and air toxics in Globeville.

Implications: Meteorological correlations and samples of volatile organic compounds (VOCs), sulfur gases, and polycyclic aromatic hydrocarbons (PAHs) in the Globeville, CO, neighborhood and near suspected sources during odor events indicate potential industrial sources of a transient and noxious odor. Legislative approaches have proven unfruitful and no health or odor thresholds were typically violated. New approaches are warranted to address odor mixture effects in neighborhoods near industrial facilities.

Introduction

Globeville is a mixed residential–industrial neighborhood of Denver, CO, that is bisected in two directions by major highways. The residential community is an island surrounded by numerous industries, including asphalt manufacturers, a wood treatment facility, a pet-food manufacturer, a stock complex, animal rendering facilities, a coal-fired power plant, two smelters, and a wastewater treatment facility. Globeville residents have faced environmental pollution for decades, beginning in 1974 when metal contamination was found in the groundwater and soil sediment, caused by the Asarco Globe Plant, now a Superfund site, after which Globeville was named (Colorado Department of Public Health and Environment [CDPHE], 2013; Environmental Protection Agency [EPA], 2013a).

Since 1980 residents have been reporting strong industrial odors. In the past few years, there has been an increase in reports of a sporadic tar or asphalt odor that is strong enough to cause eye, nose, and throat irritation and headaches. Residents are often forced to leave their patios and yards, shut windows, and turn off swamp coolers to keep the smell out of their homes. Initial conversations with elected officials, state health department staff, and others in a regulatory capacity were ineffective due to regulators' unwillingness to assist residents, as well as a lack of data conclusively identifying the odor source.

Odor exposure is a particularly difficult issue to address, given that many pollutants cause strong odors at extremely low concentrations. Nicell notes, "The more frequently an odour intrudes into a person's life, the more annoying each odour episode experience becomes" (Nicell, 2009, p. 197). This

Journal of the Air & Waste Management Association, 65(9):1127–1140, 2015. ISSN: 1096-2247 print
DOI: 10.1080/10962247.2015.1064833 Submitted March 5, 2015; final version submitted May 21, 2015; accepted June 16, 2015.

annoyance can trigger physiological mechanisms such as an instinctive odor aversion and stress-induced illness, and can exacerbate underlying health conditions (Shusterman, 1992).

During several odor events studied in California (and also those reported here), pollutant concentrations were measured well below toxicological thresholds, despite reporting of acute health symptoms experienced by residents exposed to odors (Shusterman, 1992). Therefore, reported health symptoms in these cases most likely involve odor-related mechanisms that are unrelated to toxicological health impacts (Shusterman, 1992). Furthermore, the pollutants causing the odors are often present in concentrations well below chemical detection limits. Despite this limitation, studies continue to be conducted in response to odor complaints by citizens, usually with inconclusive results about the source and the odor. Nicolas et al. (2010) emphasizes that it is important to make an assessment of the odor annoyance using the residents themselves as measuring tools, as they are experiencing the impacts firsthand. Social participation and strong community involvement are needed to identify odor sources.

Odor studies that consider input from the impacted community are not all that common. In the Bruvold et al. (1983) study of odors from wastewater treatment plants in California, affected communities had a higher percentage of respondents say that they noticed odors, and doing so more often and for longer periods of time, as compared to control communities. Also, ambient H_2S measurements confirmed higher concentrations in affected neighborhoods. This study confirmed that chemical data correlate with social data when compared with a control community.

Blood samples from residents and soil sediment and dust samples collected from homes in a neighborhood adjacent to a wood processing plant (which used creosote and pentachlorophenol) showed elevated levels of dioxins and polycyclic aromatic hydrocarbons. Air dispersion modeling indicated possible elevated air exposure to benzo[a]pyrene and tetrachlorodibenzodioxin due to the wood processing plant. These data suggested contamination of a neighborhood by the plant and the need for more stringent regulations on waste discharged from wood treatment plants (Dahlgren et al., 2003).

In response to citizen complaints, the City of Edmonton in Alberta, Canada, developed an ambient odor-monitoring program near the Edmonton Waste Management Centre (Bowker et al., 2004). Odor inspectors documented odor intensity over 3 years, and volunteer citizen odor observers maintained logs of episodes for 1 year. This program provided an inventory of odor sources with the highest frequency of detection from biosolids lagoons, composting, a chemical plant, feed mills, and a mushroom farm.

Dincer and Muezzinoglu (2006) studied the composition of odorous gases generated by a municipal landfill in the city of Izmir, Turkey. They estimated odor concentrations by olfactometry and quantified volatile organic compound (VOC) concentrations by thermal desorption gas chromatography–mass spectrometry (GC-MS). Results showed a statistically significant linear relationship between odor concentrations determined by olfactometry and total VOC concentrations. Measured VOCs were important in the odor formation and composition in selected sites that had documented odor complaints, with aldehydes, ketones, and esters as the best estimators of odor. Only one compound, however, exceeded odor thresholds (propanal).

Colorado is one of a few states that have attempted to regulate odors. Regulation 2 identifies odor as a nuisance and was adopted in 1979 to address odor emissions (Colorado Air Quality Control Commission [CAQCC], 2008). Regulation 2 states: "No person, wherever located, shall cause or allow the emission of odorous air contaminants from any single source such as to result in detectable odors which are measured in excess of one part odorous air diluted with seven units of odor free air in areas used predominantly for residential and commercial purposes" (CAQCC, 2008).

The rubric for odor violations uses a measurement system involving dilutions/threshold (D/T). Odor-free air is mixed with odor-filled air in a device called a scentometer. If an odor is detectable at a D/T of 7:1, and the origin of the odor can be determined, a written violation is permissible only if Colorado Department of Public Health and Environment (CDPHE) can prove the industry is not using best available control technology (CLCS, 2012).

In response to odor and health symptom complaints from residents in Globeville, the nonprofit organization Groundwork Denver (GWD), Globeville residents, Globeville Civic Association #1 (GCA#1), and the University of Colorado Boulder Mechanical Engineering Department (CU-ME) collaborated to collect data through air sampling, and to collect meteorology measurements. Objectives of the project were to better understand the odor and health concerns of the residents, to identify compounds present in Globeville air during odor events, to determine the likely sources of odors using wind direction, to investigate industrial processes likely to emit compounds related to detected odors, and to determine the range and frequency of impacts associated with odors. Ultimately the hope of the community was to inform next steps in addressing odor exposure in Globeville.

Experimental Methods

Residents in a 24-square-block (0.41 km^2) area in Globeville reported smelling a tar/asphalt odor. Air sampling was conducted only in this region. Figure 1 depicts the boundary of Globeville, the location of the homes where residents reported smelling the tar/asphalt odor, and the air quality sampling locations.

Air quality sampling

Air quality sampling was conducted to identify compounds present in the air when tar/asphalt odors were present, with the goal of detecting odorous and/or unique compounds that could be linked to specific industrial processes and facilities near Globeville. Three classes of compounds—volatile organic compounds (VOCs), sulfur compounds, and polycyclic aromatic hydrocarbons (PAHs)—were chosen based on their association with tar and asphalt industries, as well as the odor properties of many compounds in these classes. In total,

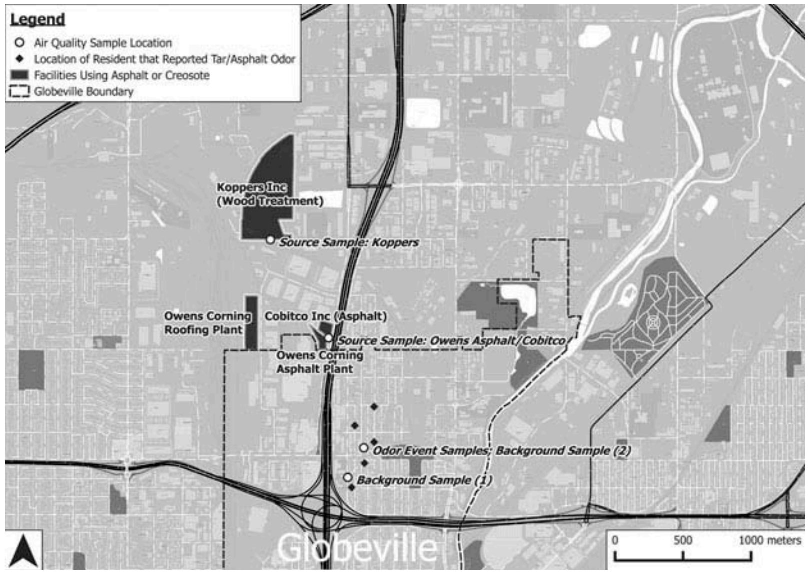

Figure 1. Map of the Globeville boundary and the location of residents that reported a tar/asphalt odor. Sampling locations are also shown.

samples were analyzed for 92 compounds, including 62 VOCs, 14 sulfur compounds, and 16 PAHs. Table 1 provides the full list of analytes.

Evacuated 6-L SUMMA canisters were used to collect grab samples to be analyzed for VOCs and sulfur compounds. Each canister was equipped with a 2-µm glass-fiber filter to prevent

Table 1. List of air quality sample analytes

Volatile organic compounds		Sulfur compounds
Dichlorodifluoromethane	Heptane	Hydrogen sulfide
Chloromethane	cis-1,3-*Dichloropropene*	Carbonyl sulfide
Freon 114	4-Methyl-2-pentanone	Methyl mercaptan
Vinyl chloride	*trans*-1,3-Dichloropropene	Ethyl mercaptan
1,3-Butadiene	1,1,2-Trichloroethane	Dimethyl sulfide
Bromomethane	Toluene	Carbon disulfide
Chloroethane	2-Hexanone	Isopropyl mercaptan
Freon 11	Tetrachloroethene	*t*-Butyl mercaptan
Freon 113	Dibromochloromethane	*n*-Propyl mercaptan
1,1-Dichloroethene	1,2-Dibromoethane	Thiophene
Acetone	Chlorobenzene	Diethyl sulfide
Carbon disulfide	Ethyl benzene	*n*-Butyl mercaptan
Methylene chloride	*m,p*-Xylene	Dimethyl disulfide
trans-1,2-Dichloroethene	*o*-Xylene	Tetrahydrothiophene
Methyl t-butyl ether	Styrene	Polycyclic aromatic hydrocarbons
Vinyl acetate	Bromoform	Acenaphthylene
2-Butanone (MEK)	1,1,2,2-Tetrachloroethane	Chrysene
cis-1,2-Dichloroethene	4-Ethyl toluene	Benzo[a]pyrene
1,1-Dichloroethane	1,3,5-Trymethylbenzene	Dibenz[a,h]anthracene
Ethyl acetate	1,2,4-Trymethylbenzene	Benz[a]anthracene
Hexane	1,3-Dichlorobenzene	Acenaphthene
Chloroform	1,4-Dichlorobenzene	Phenanthrene
Tetrahydrofuran	Benzyl chloride	Fluorene
1,2-Dichloroethane	1,2-Dichlorobenzene	Naphthalene
1,1,1-Trichloroethane	1,2,4-Trichlorobenzene	Anthracene
Carbon tetrachloride	Hexachlorobutadiene	Pyrene
Benzene	Isobutane	Benzo[g,h,i]perylene
Cyclohexane	Ethanol	Indeno[1,2,3-cd]pyrene
Trichloroethene	Isopropyl alcohol	Benzo[b]fluoranthene
1,2-Dichloropropane	Butane, 2-methyl-	Fluoranthene

large particles from being drawn in with the sample. Flow restrictors were not used, so each SUMMA canister sample was collected over a period of approximately 30 sec.

PAH samples were collected by pulling 15–30 L of air at 1 lpm ± 5% through XAD-7 OVS sorbent tubes (SKC 226-57, SKC, Inc., Eighty Four, PA) using universal sample pumps (SKC 224-PCXR8). Sample pumps were calibrated with a representative sampler in line before and after collection of each sample using a Gilian Gilibrator 2 (Sensidyne, St Petersburg, FL).

SUMMA canister and sorbent tube samples were taken concurrently, but do not perfectly represent the same time due to the large difference in sample run time for SUMMA canister samples (30 sec) compared to sorbent tube samples (15 to 30 min). In total, 10 SUMMA canister and 10 sorbent tube samples were collected, consisting of two background sets, two industrial sets at suspected source locations, and six odor sets. Background samples were collected at a vacant lot and a residential yard in Globeville at times when industrial odors were not observed. Industrial samples were collected directly adjacent to a wood treatment facility, Koppers, Inc., and on the fence line between two asphalt plants, Owens Corning Trumbull Asphalt and Cobitco, Inc., when tar/asphalt odors were present. These three facilities were identified as probable odor sources from the industry assessment (discussed later). Odor samples were collected in a residential yard in Globeville when industrial odors were observed. The sample size was limited by budget constraints.

All samples were shipped to ALS Environmental (Salt Lake City, UT, laboratory) for analysis. Samples were shipped immediately after collection and analyzed within 72 hr to minimize decay of compounds prior to analysis (Brymer et al., 1996). The SUMMA canisters were provided by ALS Environmental. ALS provided chain-of-custody forms that were used to ensure proper handling of the samples. SUMMA canister samples were analyzed for VOCs using GC-MS following method EPA TO-15 and for sulfur compounds using gas chromatography with a sulfur chemiluminescence detector. Sorbent tube samples were analyzed according to method NIOSH 5528.

CU-ME collected background and industrial samples, and trained Globeville residents to collect air samples during tar/asphalt odor events. Training of residents included an introduction to the equipment, discussion of the classes of compounds that would be analyzed, instructions on filling out sampling data sheets, a demonstration of the sampling procedure, and hands-on practice with extra samplers.

Residential samples were collected over a 7-month period from September 2012 to March 2013. The timing of sample collection depended on resident availability, concurrent observation of odors, and availability of equipment. Odor samples were collected on 9-11-12, 11-13-12, 11-19-12, 11-28-12, 12-30-12, and 3-3-13. As winter set in, the tar/asphalt odor was noticed less frequently, most likely due to more time spent indoors with closed windows.

Wind monitoring

A RainWise WindLog Data Logger (RainWise, Inc., Bar Harbor, ME) was used to monitor wind velocity and direction so that detected compounds could be linked to emissions from specific facilities. The WindLog had a minimum wind speed threshold of 0.45 m/sec and ± 2% wind speed accuracy. The wind direction range was 360° with no deadband; the resolution was 22.5°, averaged; and the accuracy was ± 22.5°. Wind speed and direction data were logged at 1-min intervals during the sampling period.

Industry assessment

An assessment of nearby industry was conducted to identify potential sources of the tar/asphalt odor. This assessment consisted of mapping and air pollutant emissions profiling. Wind data provided the basis for focusing the industry assessment on the facilities to the northwest of Globeville. Air pollutant emissions data were obtained from the Air Pollution Control Division (APCD) of the CDPHE as well as the U.S. Environmental Protection Agency (EPA) Toxic Release Inventory (TRI).

Results and Discussion

Odor event samples show high concentrations of hazardous air pollutants

All SUMMA canister and sorbent tube samples were analyzed by ALS Environmental for VOCs, sulfur compounds, and PAHs. The analytical reports provided by ALS included a qualifier for each compound indicating whether the detected concentration was below the method detection limit (MDL) or between the MDL and reporting limit (RL). The MDL is a statistical estimate of method/media/instrument sensitivity, and the RL is a verified value of sensitivity. For the purposes of this study, only compounds that were detected at concentrations greater than the RL in at least one sample were considered.

A summary of compounds found at levels above the RL in at least one sample is provided in Table 2. Concentrations of PAHs assume a pump flow rate of 1 L/min. Due to a ±5% accuracy on pump flow rate, the reported PAH concentrations also have a ±5% accuracy.

Of the 92 compounds analyzed, acetone, methylene chloride, hexane, benzene, heptane, toluene, *m,p*-xylene, and naphthalene were all present above the RL in at least half of the odor samples. Of these compounds, hexane, heptane, benzene, toluene, *m,p*-xylene, and naphthalene were present in odor samples in concentrations at least three times those found in background samples on average. These six compounds were therefore considered to be the prevalent compounds detected in the odor samples. Table 3 displays average odor sample concentrations alongside average background sample concentrations, while Table 4 lists common uses of these compounds.

Table 2. Air quality sampling results for all compounds that were detected above the RL in at least one sample (all values in ppb)

	Odor event samples						Background samples		Source samples	
Compound	9-11-12	11-13-12	11-19-12	11-28-12	12-30-12	3-3-13	7-13-12	11-20-12	Koppers 8-21-12	Owens Asphalt/Cobitco 8-21-12
VOCs (ppb)*										
Dichlorodifluoromethane	**0.69**	0.36	0.40	**0.74**	0.45	**0.58**	0.49	0.37	**0.52**	0.45
Chloromethane	0.35	0.38	0.44	**0.50**	0.46	**0.52**	**0.64**	0.41	**0.50**	0.46
1,3-Butadiene	ND	ND	**0.54**	0.28	ND	ND	ND	ND	ND	ND
Acetone	**5.90**	**1.40**	**5.90**	**7.10**	**3.60**	**5.90**	**7.10**	**1.70**	**6.00**	**11.00**
Methylene chloride	**2.20**	ND	**0.57**	**0.57**	**0.79**	0.29	**0.99**	**0.54**	**3.30**	**1.10**
2-butanone	ND	ND	**1.20**	**1.20**	ND	ND	**0.73**	**0.58**	ND	**0.69**
Ethyl acetate	ND	ND	ND	ND	ND	ND	**0.64**	ND	ND	ND
Hexane	0.30	0.28	**2.60**	**1.40**	**1.90**	ND	0.33	0.29	**0.67**	**0.57**
Tetrahydrofuran	ND	ND	ND	0.24	ND	ND	ND	**0.63**	ND	ND
Benzene	ND	0.15	**1.60**	**0.87**	**0.72**	ND	ND	0.17	0.38	0.37
Cyclohexane	ND	ND	**0.71**	0.40	**0.56**	0.24	ND	ND	ND	**0.56**
Heptane	ND	0.15	**1.10**	**0.61**	**0.50**	0.15	ND	ND	ND	0.19
Toluene	0.43	**0.90**	**6.30**	**3.70**	**1.80**	0.42	0.47	**0.73**	**1.30**	**1.70**
Tetrachloroethene	ND	ND	0.16	**1.80**	ND	ND	0.22	ND	0.35	ND
Ethyl benzene	ND	ND	**1.00**	0.44	ND	0.30	ND	ND	ND	ND
m,p-Xylene	0.24	ND	**2.90**	**1.40**	**0.68**	**0.82**	ND	0.24	0.44	0.30
o-Xylene	ND	ND	**0.91**	0.42	0.19	0.43	ND	ND	ND	ND
1,2,4-Trimethylbenzene	ND	ND	**0.86**	0.44	ND	**1.20**	ND	ND	ND	ND
Sulfur compounds (ppb)										
Carbon disulfide	ND	ND	ND	ND	ND	ND	**5.90**	ND	ND	**6.00**
PAHs** (ppb)										
Naphthalene	**25.00**	ND	ND	**1.50**	**0.33**	ND	ND	ND	**1.50**	ND
Dibenz[a,h]anthracene	**2.70**	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo[g,h,i]perylene	**1.70**	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno[1,2,3-cd]pyrene	**2.10**	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes: MDL = method detection limit, a statistical estimate of method/media/instrument sensitivity. MDL for VOCs: 0.15 ppb. RL = reporting limit, a verified value of method/media/instrument sensitivity. RL for VOCs: 0.50 ppb; for sulfur compounds: 3.50 ppb; for PAHs: 0.10 μg/sample. ND = not detected, testing result not detected above the MDL or RL. Boldfaced values are those greater than the RL. Odor indicates samples that were collected during an odor episode in a residential yard in Globeville; background indicates samples that were collected when there was no odor episode in a vacant lot and residential yard. See Figure 1 for sampling locations.

*VOCs and sulfur compounds were collected using SUMMA canisters.

**PAHs were collected using sorbent tubes and sampling pumps; concentrations are ±5% due to pump flow rate accuracy limitations.

Table 3. Odor event and background sample average concentrations (values in ppb)

Compound	Odor event samples average (n = 6)	Background samples average (n = 2)	Ratio: odor average/background average
VOCs (ppb)			
Dichlorodifluoromethane	0.54	0.43	1.3
Chloromethane	0.44	0.53	0.8
1,3-Butadiene	0.14	0.00	—
Acetone	4.97	4.40	1.1
Methylene chloride	0.74	0.77	1.0
2-Butanone (MEK)	0.40	0.66	0.6
Ethyl acetate	0.00	0.32	0.0
Hexane	**1.08**	**0.31**	**3.5**
Tetrahydrofuran	0.04	0.32	0.1
Benzene	**0.56**	**0.09**	**6.2**
Cyclohexane	0.32	0.00	—
Heptane	**0.42**	**0.00**	**—**
Toluene	**2.26**	**0.60**	**3.8**
Tetrachloroethene	0.33	0.11	3.0
Ethyl benzene	0.29	0.00	—
***m,p*-Xylene**	**1.01**	**0.12**	**8.4**
o-Xylene	0.33	0.00	—
1,2,4-Trimethylbenzene	0.42	0.00	—
Sulfur compounds (ppb)			
Carbon disulfide	0.00	2.95	0.00
PAHs* (ppb)			
Naphthalene	**4.47**	**0.00**	**—**
Dibenz(a,h)anthracene	0.45	0.00	—
Benzo(g,h,i)perylene	0.28	0.00	—
Indeno(1,2,3-cd)pyrene	0.35	0.00	—

Notes: Boldfaced compounds are those that were detected above the RL in at least half of the odor samples and had an odor sample average concentration at least three times greater than average background concentrations. Odor event indicates samples that were collected during an odor episode in a residential yard in Globeville. Background indicates samples that were collected in a vacant lot and residential yard when there was no odor episode. See Figure 1 for sampling locations.

*PAH concentrations are ±5% due to pump flow rate accuracy limitations.

Table 4. Uses of industrial compounds detected in Globeville air quality samples

Compound	Use
Hexane[1]	Edible-oil extractant for seed crops; solvent and cleaning agent in the textile, shoe and leather, and furniture industries; various uses in printing; glues and adhesives
Heptane[2]	Standard for octane-rating determinations; anesthetic; solvent; organic synthesis; preparation of laboratory reagents
Benzene[3]	Solvent in chemical and drug industries; starting and intermediate material in chemical synthesis; gasoline additive
Toluene[4]	Starting material in benzene production; solvent in paints, coatings, adhesives, inks, and cleaning agents; gasoline additive
m,p-Xylene[5]	Starting material in ethyl benzene production; solvent in paints and coatings; gasoline additive
Naphthalene[6]	Intermediate in production of phthalic anhydride, insecticide carbaryl, synthetic leather-tanning agents, and surface active agents; moth repellent

Notes: References: 1 (ATSDR, 1999), 2 (Lewis R.J., 2001), 3 (ATSDR, 2007a), 4 (ATSDR, 2000), 5 (ATSDR, 2007b), 6 (ATSDR, 2005).

Figure 2 displays the concentrations for all 10 samples of each of the six compounds that were detected above the RL in at least half of the odor samples and that had average odor sample concentrations at least three times greater than average background concentrations.

Sulfur compounds were not detected in any odor sample. Carbon disulfide, however, was detected at 5.9 ppb in one background sample and 6 ppb in the sample collected on the Owens Corning Trumbull Asphalt Plant and Cobitco, Inc., fence line.

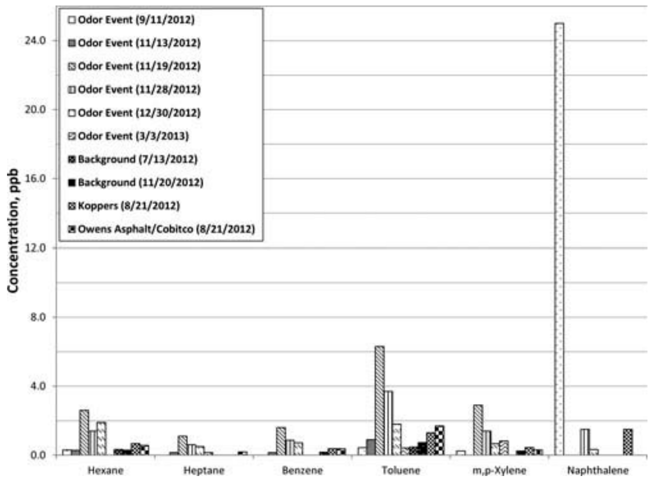

Figure 2. Odor, background, and industrial sample concentrations of compounds detected in odorous air. Odor indicates samples that were collected during an odor episode in a residential yard in Globeville; background indicates samples that were collected in a vacant lot and residential yard in Globeville when there was no odor episode; industrial samples were collected directly adjacent to a wood treatment facility, Koppers, Inc., and on the fence line between two asphalt plants, Owens Corning Trumbull Asphalt and Cobitco, Inc., when tar/asphalt odors were present. See Figure 1 for sampling locations.

The odor sample collected on 9-11-12 showed a high concentration of naphthalene, 25 ppb, along with detectable concentrations of three other PAHs: dibenz[a,h]anthracene, benzo[g,h,i]perylene, and indeno[1,2,3-cd]pyrene. In addition to its presence in this first odor sample, naphthalene was detected in two other odor samples and in the Koppers, Inc., industrial sample (Figure 2).

Of the compounds listed in Table 3, all except heptane are listed as hazardous air pollutants (HAPs) by the EPA. HAPs, also known as air toxics, are "pollutants that cause or may cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental and ecological effects" (EPA, 2012). HAPs are regulated by establishing control technology requirements on major sources, that is, sources that emit more than 10 tons per year of a single HAP or more than 25 tons per year of a mixture of HAPs.

Wind in Globeville is typically light

Minute wind speed and direction data were collected from September 2012 through March 3, 2013, with one 2-week period from October 3 to October 16 lost due to dead batteries. These data were used to develop an understanding of general wind patterns in Globeville, as well as an understanding of wind activity during air quality sampling.

As shown in Figure 3, Globeville experienced calm conditions and low wind speeds of less than 3 m/sec for the majority of the sample period. There was no wind (< 0.1 m/sec) nearly 25% of the time, and wind below 2 m/sec (approximately the lower threshold of a "light breeze" on the Beaufort scale) another 68% of the time (Beaufort, 1805). The light breeze that did occur was a southwesterly wind approximately 18% of the time, and was spread somewhat equally around the compass the remaining 58% of the time.

All observed tar/asphalt odor events occurred during NNW winds

Wind plots displaying direction and time of day were generated for each odor sample. Figure 4 shows a 3.5-hr period encompassing the odor sample taken on 11-13-12.

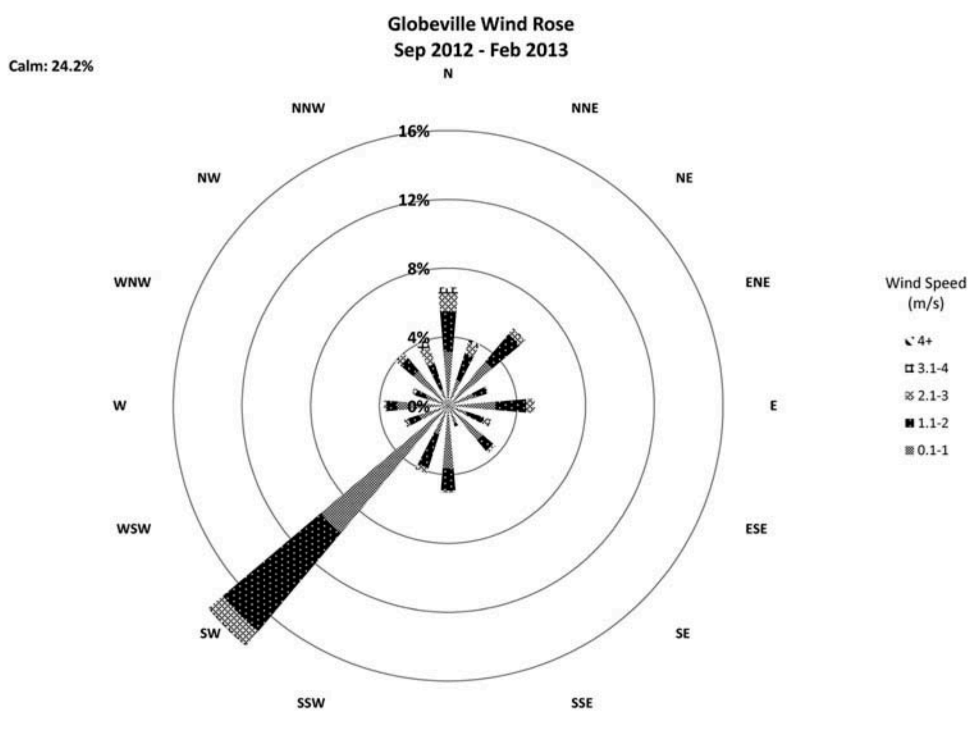

Figure 3. Wind rose summarizing wind speed and direction for the air monitoring period.

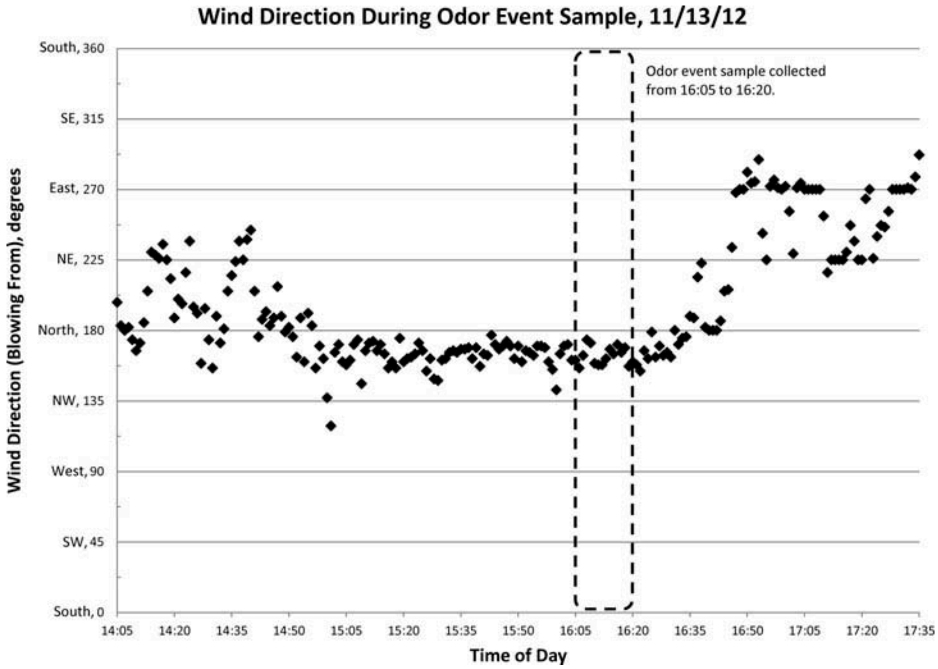

Figure 4. Wind direction versus time of day for odor sample collected on 11-13-12 (sample collected from 4:05 p.m. to 4:25 p.m.).

The odor sample dated 11-13-12 was collected from 4:05 p.m. to 4:20 p.m., as indicated by the dashed box in Figure 4. A light 2–4 m/sec north by northwest breeze held for at least 1 hr leading up to the odor sample and throughout sample collection. Wind blowing from the NNW corresponds to wind blowing into Globeville from the industrial area that contains that most likely odor sources. This observation—a NNW breeze leading up to and lasting throughout odor samples—was consistent for all six odor event samples.

The wind speed during odor samples varied. There was essentially no wind during odor sample collection on 11-19-12, 11-28-12, and 12-30-12, but a slight NNW breeze preceded each of these samples. Wind speeds during samples collected on 9-11-12, 11-13-12, and 3-3-13 ranged from 1.5 to 4.5 m/sec.

Upwind industrial facilities are permitted to emit hazardous air pollutants

Globeville is surrounded by a multitude of potential industrial odor sources, including Nestle Purina Pet Care, National Western Stock Show, Suncor Energy, Darling International, Metro Wastewater Reclamation, Koppers, Inc., Altogether Recycling, Owens Corning Denver Trumbull Asphalt Plant, and Owens Corning Roofing Plant (Figure 5).

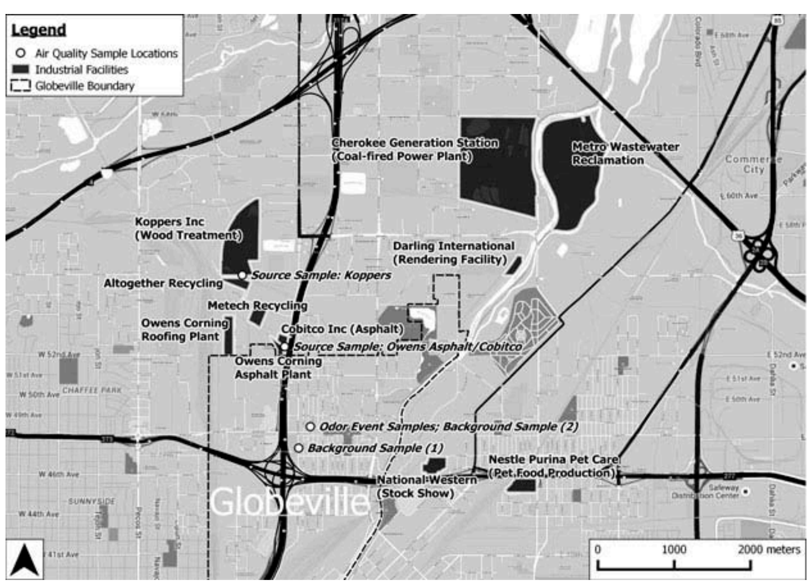

Figure 5. Industrial facilities near to Globeville.

Observations of wind direction during tar/asphalt odor episodes were used to target the most relevant facilities. Given that the wind always came from the NNW when the tar/asphalt odor was observed, all of the facilities to the east of I-25 in Figure 5 were eliminated from consideration. The industrial area NNW of Globeville was then mapped more thoroughly. Six facilities were located close to Globeville and west of I-25: Koppers, Inc. (wood treatment), Altogether Recycling, Owens Corning Roofing Plant, Owens Corning Trumbull Asphalt Plant, Cobitco Inc. (Asphalt), and Metech Recyling. Of these six facilities, only Koppers, Inc., Cobitco, Inc., and the Owens Corning facilities were considered likely to produce a tar/asphalt odor.

The Denver Koppers, Inc., facility (Figure 5) is a wood treatment plant that applies a proprietary blend of coal tar creosote—referred to as Creosote Petroleum Solution, or CPS—to railroad ties as a preservative. The Material Safety Data Sheet (MSDS) for CPS lists numerous PAHs as constituents, including the following pollutants detected in Globeville odor samples: naphthalene, dibenz[a,h]anthracene, benzo[g,h,i]perylene, and indeno[1,2,3-cd] pyrene. Furthermore, the MSDS lists the potential short-term health effects of inhalation as "irritation, nausea, vomiting, headache, drowsiness, dizziness, loss of coordination" (Koppers, Inc., 2012).

The three primary sources of air emissions at wood treatment facilities are off-gassing of treated wood immediately after removal from the treating cylinder, venting of the vacuum pump system, and venting of displaced air when creosote is returned to the work tanks (EPA, 1999).

Cobitco, Inc. (Figure 5), creates asphalt emulsions for use in road paving. Asphalt emulsions combine asphalt, water, and an emulsifying agent to produce a liquid product suitable for road construction and maintenance (Asphalt Emulsion Manufacturers Association [AEMA], n.d.). The only compound listed on any Cobitco, Inc., MSDS that was covered in the air quality sampling program is a styrene/butadiene copolymer (Chemical Safety Associates, Inc., 2004). Exposure to asphalt via inhalation is not expected under normal operating conditions at Cobitco, Inc., but asphalt inhalation can cause "difficulty breathing, wheezing, headache, dizziness, indigestion, and nausea" if it occurs (Chemical Safety Associates, Inc., 2004).

There are two Owens Corning facilities near Globeville (Figure 5): Denver Trumbull Asphalt Plant at 5201 Bannock Street and Owens Corning Roofing Plant at 5201 Fox Street. Trumbull asphalt products are used for roofing shingles, built-up roofing systems, and roadway paving (Owens Corning, 2010). The roofing facility produces four types of shingles. The MSDS for the primary asphalt product at this facility states that "fumes from hot materials can be unpleasant and produce nausea, headaches and irritation of the upper respiratory tract" (Owens Corning, 2012). The only pollutant specifically mentioned in this MSDS is hydrogen sulfide (H_2S).

The EPA's TRI reports and the APCD construction permits were reviewed for these facilities to develop an understanding of the relative quantities of air pollutant emissions from each.

Cobitco, Inc., only lists hydrochloric acid on its TRI reports, and it has reported zero pounds released every year since 1995 (EPA, 2013b). Both Owens Corning facilities list benzo[g,h,i] perylene and PAHs, but the Trumbull Asphalt Plant has always reported zero pounds released (EPA, 2013c). The Roofing Plant listed 1 kg of PAHs released for the years 2006 to 2011 (EPA, 2013d).

Table 5. Koppers Inc. creosote releases as reported to the TRI

Year	Fugitive air emissions (kg)	Stack air emissions (kg)	Total air emissions (kg)
2006	1,724	1,179	2,903
2007	1,451	454	1,905
2008	1,814	499	2,313
2009	1,542	680	2,223
2010	590	236	826
2011	726	331	1,057

Koppers, Inc., reported creosote air emissions for 2006 to 2011 as shown in Table 5 (EPA, 2013e).

The only specific component of creosote air emissions regulated by the APCD is naphthalene. Koppers, Inc., is permitted to emit up to 8,160 kg per year of naphthalene from its wastewater treatment (WWT) system and up to 59 kg per year of naphthalene from its creosote storage tank, as shown in Table 6 (APCD, 2009a, 2010).

Facility-wide APCD construction permits were obtained for both Owens Corning facilities (APCD, 2003, 2007, 2009b); permits for two specific pieces of equipment were obtained for Koppers, Inc. (APCD, 2009a, 2010); and no permit was obtained for Cobitco, Inc. Emissions limits for non-criteria reportable air pollutants based on current construction permits are listed for both Owens Corning facilities (Table 7) and for a portion of the Koppers, Inc., facility (Table 6).

A literature search was conducted for odor complaints about other Koppers, Inc., and Owens Corning facilities. There are no other Cobitco, Inc., facilities. The Agency for Toxic Substances and Disease Registry (ATSDR) conducted a public health assessment of the Koppers wood treatment facility in Little Rock, AR, in response to community concerns over groundwater contamination and odors (Arkansas Department of Health, 2005). In response to odor complaints, ATSDR collected data on airborne concentrations of PAHs and other VOCs. Canister samples yielded naphthalene concentrations ranging from 5.5 to 44.5 ppb. In comparison, naphthalene concentrations detected in Globeville odor samples ranged from ND to 25 ppb (Table 2).

Table 6. Koppers Inc. emissions of non-criteria reportable air pollutants as listed in APCD construction permits

		Emissions (kg/yr)	
CAS number	Substance	Koppers WWT* effluent tank[1]	Koppers Creosote storage tank[2]
92-52-4	Biphenyl	115	1
132-64-9	Dibenzofuran	9	0
86-73-7	Fluorene	245	2
91-20-3	Naphthalene	8,160	59
91-22-5	Quinoline	263	2

Notes: References: 1 (APCD, 2010); 2 (APCD, 2009a).
*WWT—wastewater treatment.

Table 7. Owens Corning emissions of non-criteria reportable air pollutants as listed in APCD construction permits

		Emissions (kg/yr)	
CAS number	Substance	Owens Roofing Plant[1,2]	Owens Asphalt Plant[3]
71-55-6	1,1,1 Trichloroethane	174	
	Arsenic compounds	1	
71-43-2	Benzene	169	2,972
106-99-0	Butadiene		100
67-66-3	Chloroform		27
	Chromium compounds	59	
	Cobalt compounds	5	
100-41-4	Ethylbenzene	51	2,828
50-00-0	Formaldehyde	52	
7647-01-0	Hydrochloric acid	62	7,257
7439-92-1	Lead compounds	6	
	Manganese compounds		55
74-87-3	Methyl chloride		181
78-93-3	Methyl ethyl ketone*	4,062	
75-09-2	Methylene chloride		308
	Nickel compounds		64
	Selenium compounds	1	
100-42-5	Styrene		1,633
108-88-3	Toluene	291	
108-05-4	Vinyl acetate		4,694

Notes: References: 1 (APCD, 2003), 2 (APCD, 2009b), 3 (APCD, 2007).
*Methyl ethyl ketone was removed from the list of hazardous air pollutants in 2005, and therefore removed from the Owens Corning permit. The 2003 permit value is listed as a reference.

No complaints or health assessments were found in published studies for Owens Corning facilities.

Health and odor thresholds not met for prevalent compounds in odor event samples

Odor and health effect thresholds have been established for each of these compounds. Table 8 presents the maximum concentrations found in Globeville odor samples alongside typical urban concentrations, odor thresholds, and health effect thresholds.

Odor thresholds are established by exposing a panel of individuals to known concentrations of a compound to determine the minimum concentration required for the panelists to observe the odor. Odor thresholds reported in the literature vary substantially due to the variety of definitions and methods followed. An odor threshold can be defined as the "minimum concentration of an odorant which produces a noticeable change in the odor of the system" or as "the minimum concentration at which the odor quality (description of smell) of the compound can be described" (Ruth, 1986). The odor panel can consist of trained or untrained individuals. Furthermore, the threshold can be set based on the concentration at which one panelist, half the panelists, or all of the panelists detect the odor. Odor thresholds are established based on exposure to pure compounds and not compounds in mixtures. It is not known how mixtures affect odor thresholds (Ruth, 1986). This is a significant gap in the literature, given that ambient air in industrial areas will always contain a mixture of compounds.

The odor thresholds reported in Table 8 are based on literature reviews by the EPA (EPA, 1992) and by the ATSDR (ATSDR, 1999, 2000, 2005, 2007a, 2007b). Heptane was not referenced in either of these compilations as it is not a HAP; therefore, an independent study of odor thresholds was used for heptane (Amoore and Hautala, 1983).

The single-compound odor thresholds for hexane, heptane, benzene, and toluene are three to five orders of magnitude greater than the maximum concentrations detected in the odor samples. Therefore, these compounds likely did not contribute to observed tar/asphalt odors during the sample period. The maximum detected concentration of *m,p*-xylene came within one to two orders of magnitude of the odor threshold; the maximum detected concentration of naphthalene (25 ppb) was on the same order of magnitude as the odor threshold (38 ppb).

Although naphthalene was never detected at concentrations greater than the published odor threshold, it is likely that naphthalene, which is known to have a coal tar odor, contributed to tar/asphalt odor observations during the sample period. It is possible that naphthalene concentrations in the samples partially degraded before analysis, or that odor thresholds established based on exposure to pure naphthalene do not accurately represent scenarios in which residents are exposed to naphthalene in mixture with other PAHs. For example, the Koppers, Inc., APCD permit lists quinoline (also known as benzo[b]pyridine) emissions of nearly 600 lb per year. Quinoline was not included in the air quality sampling program, but it is a compound derived from coal tar that is known to have an unpleasant odor above an odor threshold of 5.3 ppm (EPA,

Table 8. Odor event sample concentrations of compounds detected in Globeville odor samples compared to odor and health effect thresholds

						Non-Carcinogenic Health Thresholds		Carcinogenicity	
	Odor sample maximum (ppb)	Background sample average (ppb)	Typical urban concentration (ppb)	Odor descriptors[2]	Odor threshold (ppb)	TLV (ppb)[3] STEL (ppb)[3]	Acute MRL (ppb), intermediate MRL (ppb), chronic MRL (ppb)	E-6 cancer risk level (ppb)[4]	Category[4]
Hexane	2.60	0.31	2–25[1]	Faint, gasoline	130,000[1] 65,000[2]	50,000 —	— — 600[1]	—	—
Heptane	1.10	0	Median: 0.06[5]	Mild, gasoline-like[6]	150,000[7]	400,000 500,000	—	—	D
Benzene	1.60	0.09	3.0–6.6 Median: 4.1[8]	Aromatic, sweet, solvent	61,000[2,8]	10,000 —	6 4 3[8]	0.04	A
Toluene	6.30	0.6	0.27–7.98 Median: 2.88[9]	Sour, burnt, benzene-like	8,000[9] 2,800[2]	50,000 —	1000 — 80[9]	—	—
m,p-Xylene	2.90	0.12	1–30 Median: 2.8[10]	Sweet	50[10] 730[2]	100,000 150,000	2000 600 50[10]	—	—
Naphthalene	25.0	0	0.08–32.43 Median: 0.18[11]	Tar, creosote, mothballs	84[11] 38[2]	10,000 15,000	— — 0.7[11]	—	C

Notes: Definitions of health thresholds: TLV: American Conference of Governmental and Industrial Hygienists' (ACGIH) threshold limit value expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed 8 hr per day without adverse effects. STEL: ACGIH's short-term exposure limit; a 15-min time-weighted-average exposure, which should not be exceeded at any time during a workday. MRL: Minimal risk level; an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure. Acute MRL: minimal risk level for acute-duration inhalation exposure (14 days or less). Intermediate MRL: minimal risk level for intermediate-duration inhalation exposure (15–364 days). Chronic MRL: minimal risk level for chronic-duration inhalation exposure (365 days or more). E-6 Cancer Risk Level: the concentration to which a lifetime of exposure will cause no more than a one-in-a-million increased chance of developing cancer. Cancer Risk Categories: A, known human carcinogen, B, probable human carcinogen, C, possible human carcinogen, D, not classifiable as a human carcinogen, E, evidence of noncarcinogenicity. References: 1 (ATSDR, 1999), 2 (EPA, 1992), 3 (Lewis R.J., 2001), 4 (EPA, 2013f), 5 (Jia, Batterman, & Godwin, 2008), 6 (OSHA), 7 (Amoore & Hautala, 1983), 8 (ATSDR, 2007a), 9 (ATSDR, 2000), 10 (ATSDR, 2007b), 11 (ATSDR, 2005).

1992). While it is unknown whether quinoline concentrations exceeded 5.3 ppm in Globeville, it is possible that the interaction of multiple odorous compounds creates a noticeable tar/asphalt odor.

Health thresholds reported in Table 8 include the threshold limit value (TLV); the short-term exposure limit (STEL); acute, intermediate, and chronic minimal risk levels (MRLs); and the per million (E-6) Cancer Risk Level. The TLV and STEL are exposure limits for workers set by the American Conference of Governmental and Industrial Hygienists (ACGIH). The TLV is an 8-hr time-weighted average concentration to which workers can be exposed without adverse health effects (EPA, 2009). The STEL is a 15-min time-weighted average acute exposure threshold that should not be exceeded at any time during a workday (EPA, 2009). An MRL, established by ATSDR, is "an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure" (ATSDR, 2013). Durations of exposure include acute (14 days or less), intermediate (15 to 364 days), and chronic (365 days or more). Finally, the per million Cancer Risk Level, reported in the EPA Integrated Risk Information System (IRIS), is the concentration to which a lifetime (70 years) of exposure will cause no more than a 1-in-a-million increased chance of developing cancer (EPA, 2013f). Compounds are assigned a letter A through E corresponding to their likelihood of causing cancer as follows: A, known human carcinogen, B, probable human carcinogen, C, possible human carcinogen, D, not classifiable as a human carcinogen, and E, evidence of noncarcinogenicity.

All health thresholds for hexane, heptane, toluene, and *m,p*-xylene are at least one order of magnitude greater than the maximum detected concentrations of these compounds.

Both the maximum detected concentration of naphthalene (25 ppb) and the odor sample average concentration (4.47 ppb) exceed the chronic MRL (0.7 ppb). The maximum detected concentration of benzene (1.60 ppb) was just below the chronic MRL (3 ppb); both the maximum and the odor sample average benzene concentration (0.56 ppb) far exceeded the per million Cancer Risk Level (0.04 ppb). Although short-term exposure to hexane, heptane, benzene, toluene, *m,p*-xylene, and naphthalene is not expected to cause adverse health effects at the concentrations detected in the odor samples, uncertainty about duration of exposure in Globeville and exposure from other sources near Globeville provide grounds for further studies.

The following HAPs were detected in one or two odor samples: chloromethane, 1,3-butadiene, 2-butanone (methyl ethyl ketone, or MEK), ethyl benzene, and *o*-xylene. As these compounds were present in less than half of the odor samples, it is unlikely that their presence was related to the tar/asphalt odor.

Odor sample pollutants linked to facilities

Some pollutants that were detected in odor samples can be linked to specific facilities based on the emissions reported in APCD permits and in the TRI.

The presence of naphthalene and other PAHs in the odor event samples indicates emissions from Koppers, Inc. Although these compounds are often listed as common pollutants from asphalt plants (ATSDR, 1995), they are not listed in the TRI reports for Cobitco, Inc. (EPA, 2013b), nor for Owens Corning Trumbull Asphalt Plant (EPA, 2013c). The Owens Corning Roofing Plant reported only 1 kg of PAHs released to the air in 2011 (EPA, 2013d), as compared to 1,057 kg reported by Koppers, Inc. (EPA, 2013e). Furthermore, the Koppers, Inc., APCD permit lists emissions of more than 8,000 kg per year of naphthalene for the wastewater treatment system alone (APCD, 2010), whereas naphthalene is not listed in any Owens Corning permit (APCD, 2003, 2007, 2009b). The Cobitco permit could not be obtained from the APCD, but the MSDS available on the Cobitco, Inc., website does not list naphthalene or any other PAH (Chemical Safety Associates, Inc., 2004). Given that naphthalene is not typically found in urban air at concentrations at levels as high as those found in the Globeville odor samples (ATSDR, 2005), and that naphthalene was not detected in background samples in Globeville, it can be assumed that naphthalene in the samples originated from Koppers, Inc.

As mentioned previously, off-gassing of treated wood is a primary source of emissions from Koppers, Inc. In a successful effort to remove wood treatment facilities from the EPA list of industries that must apply best available control technology (BACT) in order to control HAP emissions, the American Wood Preservers Institute (AWPI) conducted a study proving that naphthalene emissions from treated wood storage at Koppers, Inc., total less than 10 tons per year (Wikstrom et al., n.d.). This very study, however, demonstrated elevated naphthalene emissions during the first 10 to 20 hours immediately following wood treatment (Figure 6).

The daily operating schedule of Koppers, Inc., was not determined, but it is possible that tar/asphalt odors are observed in Globeville when north by northwesterly winds occur within 1 day of wood treatment at Koppers, Inc.

Hexane, heptane, benzene, toluene, and *m,p*-xylene are all common industrial pollutants that cannot be linked to any one facility. Benzene, toluene, and *m,p*-xylene are also found in automotive exhaust due to the use of BTEX (benzene, toluene, ethylbenzene, and xylenes) as a gasoline additive (ATSDR,

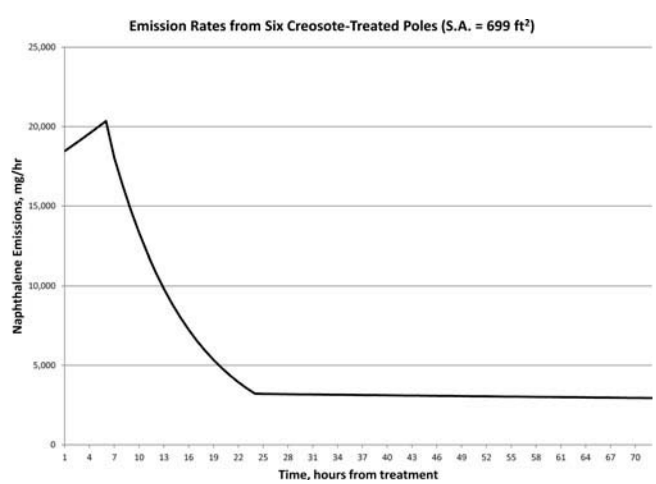

Figure 6. Modeled naphthalene emissions from treated wood storage, reproduced from data in Wikstrom et al. (n.d.).

2000, 2007a, 2007b). Therefore, the major highways bisecting Globeville likely contribute to the presence of these pollutants in the samples. However, the Owens Corning Asphalt Plant permit does list benzene emissions of 2,972 kg per year, as compared to 169 kg per year for Owens Corning Roofing Plant and no benzene emissions from Koppers, Inc. Therefore, the Owens Corning Asphalt Plant is more likely to have contributed to the benzene concentrations found in odor samples than the other facilities in the area.

Conclusion

Residents of Globeville have been complaining for years of transient and noxious odors in their neighborhood. An independent investigation of specific complaints related to asphalt/tar odors was conducted for the neighborhood through air quality sampling of odor events, and background and source location samples. Detailed wind monitoring and an industry assessment were also conducted. Results showed naphthalene to be the predominant and elevated pollutant, and that odor events occur when the wind comes from the north-northwest. Naphthalene is reported in permits to be emitted from Koppers, Inc., a wood treatment facility.

Regulation 2 (Reg 2) is Colorado's current approach to addressing and regulating odors. It has proven ineffective for addressing Globeville's odor events. Despite residents calling and asking for Reg 2 assessments, no violation has been recorded. For example, one odor event that occurred in September 2011 was reported to CDPHE and investigated by an odor inspector. The wind was out of the WNW at 1–3 mph, but odor could not be detected at a dilution of 2:1. The odor dissipated as rain began to fall and the investigation was concluded (CDPHE, 2011). Current strategies for investigating odor do not sufficiently take into account rapidly changing climatic conditions (i.e., wind direction shifts), nor the time and staff required to properly address odor concerns. Reg 2 is not necessarily protective of public health for these reasons, among others. Numerous variables influence odor detection and therefore determine odor violations: rapidly changing and unpredictable meteorological conditions, individual sensitivity to odors, and odors mixing in ambient air.

What can be done about the odor related to asphalt/tar in Globeville? Some residents have taken matters into their own hands and moved out of the neighborhood (M. Escamilla, personal communication, 2013). Research is needed to understand odor mixtures compared to single compound toxicity. A more detailed study should be undertaken to elucidate the impacts of odor in communities such as Globeville, including assessing acute and long-term health effects, as well as stress and well-being issues.

Legislative approaches have proven unfruitful and no health or odor thresholds were typically violated. A new regulation that is focused on neighborhood odors could use a panel of residents in various land use types to address specific odors, as well as rates of sensitivity based on residence in certain neighborhoods. New approaches are warranted to address odor mixture effects in neighborhoods near industrial facilities. Given the technical and regulatory challenges of sampling odors and controlling emissions, it is recommended that Globeville residents and neighboring industry pursue a "good neighbor policy" to solve the odor issue. Specific offending industrial processes could be identified for which there exist cost-effective control technologies that would reduce exposure to odors and air toxics in Globeville.

Acknowledgment

The authors appreciate all participants, including Margaret and Robert Escamilla, who dedicated their time and energy to fighting for improved air quality in Globeville, as well as providing a base for air sampling. Thank you to the Globeville residents, and Sunnyside and Chaffee Park, for participating in this study.

Funding

The U.S. Environmental Protection Agency funded this study through an Environmental Justice grant to Groundwork Denver, Grant EQ-96815901.

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About the Authors

Blayne Morgan was an M.S. student in the Civil, Environmental, and Architectural Engineering Department at the University of Colorado, Boulder, CO, but now works at SCS Engineers in Santa Maria, CA.

Rachel Hansgen was a M.P.H. student in the Colorado School of Public Health at the University of Colorado, Denver, CO, but now works at Groundwork Denver.

Wendy Hawthorne is the executive director of Groundwork Denver, Denver, CO.

Shelly L. Miller is a professor in the Mechanical Engineering Department at the University of Colorado, Boulder, CO.

May 11, 2020

Susan Affleck - Childs
Planning and Economic Development Coordinator
Town of Medway
155 Village Street
Medway, MA 02053
508-533-3291
Email: sachilds@townofmedway.org

Re: Odor Standards

Dear Ms. Affleck - Childs:

This letter documents the findings from my review of the proposed revisions to the Environmental Standards Section 7.3 of the Medway Zoning Bylaw and provides further explanation of my recommendations. Discussions from the 4-28-2020 Planning Board meeting and all documents provided by local resident Mr. John Lally have been considered and taken into account. My recommended edits to the standard are attached.

Summary:

In order to determine whether or not an odor producing facility is in compliance with the standard, I recommend using two criteria – an Annoyance Criterion and an Ambient Odor Detection Threshold Criterion. If a facility fails to meet *either one* of the criteria, then the facility is in non-compliance. I do not recommend using Ambient Odorant Mass Concentration criteria in odor laws as explained below.

Annoyance Criterion

An Annoyance Criterion uses a single statement to define a nuisance or an objectionable odor. No artificial devices or field instruments are needed to determine compliance with this criterion. It is simply an odor inspector using their own sense of smell to determine if an odor would be objectionable to a reasonable person. However, in order to achieve objective and consistent results, it is recommended that all odor inspectors be trained in odor measurement, regardless of what type of odor law compliance criterion they are using. The Annoyance Criterion is defined in Paragraph A Purpose where it defines and prohibits “disturbing or offensive” odors. This is further clarified in Paragraph 4. Odors.

Ambient Odor Detection Threshold Criterion

An Ambient Odor Detection Threshold Criterion uses a Dilution-to-Threshold ratio standard, which is measured by a field olfactometer. This method of measuring odor strength has been in use since the 1960s. It is based on the concept that the odor concentration that causes annoyance to a person (the annoyance threshold, AT) is a higher concentration than what causes an odor to be barely detectable by a person (the detection threshold, DT). When done by trained inspectors, it is considered to be an objective, cost effective, and widely accepted method to measure odor strength. The higher the measured D/T, the stronger the odor. For example, an odor measured to be a D/T 7 is a stronger odor than one measured to be a D/T 4. In the early years of field olfactometry, it was found that in general, an odor measuring D/T 2 would be noticeable but not objectionable; and an odor measuring D/T 7 would be objectionable. I recommend that an odor measuring D/T 7 constitutes non-compliance and odors measured to have a D/T of any value higher than 7 would obviously also be in non-compliance.

Ambient Odorant Mass Concentration Criteria

The prior version of the Environmental Standard 7.3 listed the criterion "0.001201 oz. per thousand cubic feet of hydrogen sulfide" and also referenced a table published in 1951 of odor criteria of more than 100 chemical compounds. This is an example of Ambient Odorant Mass Concentration Criteria. I do not recommend using this type of criteria in odor laws for a multitude of reasons. The biggest reason it that these concentration values are known and published extensively only for *individual compounds.* Odors from industrial and commercial sources typically consist of a mixture of many different compounds, and the effect of one compound on another compound within the overall odorant mixture may not be known or readily determined. Measurements of mass concentration for a compound can only be made in the field with an instrument containing a sensor designed to measure that specific compound. Such instruments can be expensive and may not be readily available for some common compounds. Air samples can be bagged in the field and sent to a lab for analysis, but this can be cost prohibitive and poses the risk of samples degrading while in transit. Published odor threshold values for mass concentrations of compounds generally contain detection threshold and recognition threshold values, but do not contain annoyance threshold values. Even if one assumes that an annoyance threshold could be calculated based on a detection threshold, the published values vary by orders of magnitude between the various sources that developed them. Selecting the lowest concentration published for use in an odor law would require verifying that the value was measured using current industry standard methodology.

Respectfully,

Bruce Straughan, PE
Straughan Forensic, LLC

7.3. ENVIRONMENTAL STANDARDS

A. **Purpose**. The intent of this section is to provide standards for uses that may generate impacts that are potentially hazardous, harmful to the environment, disturbing or offensive. Medway Zoning Bylaws, § 5.2, Prohibited Uses, expressly prohibits all uses in any district that pose a present or potential hazard to human health, safety, welfare, or the environment through the emission of smoke, particulate matter, noise or vibration, or through fire or explosive hazard, or light and shadow flicker. Furthermore, Medway Zoning Bylaws, § 5.2, Prohibited Uses, B.14 prohibits any use that produces "disturbing or offensive" noise, vibration, smoke, gas, fumes, odors, dust or other objectionable or hazardous features. For the purposes of this section, "disturbing or offensive" impacts are those that a reasonable person with normal sensitivity would find objectionable, as interpreted by the Building Commissioner/Zoning Officer or his or her designee.

B. **Enforcement**: Medway Zoning Bylaws, § 3.1, Enforcement, Violations, and Penalties authorizes the Building Commissioner to interpret and enforce this Bylaw. In addition, the police department, fire department, or board of health officials are authorized to enforce standards that are based on certain sections of 310 CMR, § 7, Air Pollution Control Regulations. At the discretion of the Building Commissioner/Zoning Enforcement Officer or the Planning and Economic Development Board, a technical consultant may be engaged by the Town of Medway to investigate and document violations.

C. **Standards.** The following standards shall apply to all districts and shall be determined at the location of use:

1. **Smoke, Fly Ash, Dust, Fume, Vapors, Gases, Other Forms of Air Pollution:** Medway Zoning Bylaw, § 5.2, Prohibited Uses, 14, prohibits any use "that produces disturbing or offensive noise, vibration, smoke, gas, fumes, odors, dust or other objectionable or hazardous features." In addition, all activities involving smoke, fly ash, dust, fume, vapors, gases, other forms of air pollution, as defined in CMR 310, § 7, Air Pollution Control Regulations, as amended, prohibits emissions which can cause damage to human health, to animals or vegetation, or other forms of property, or which cause any excessive soiling at any point.

2. **Noise Disturbance:** No person or persons owning, leasing or controlling the operation of any source or sources of noise shall willfully, negligently, or through the failure to provide necessary equipment or facilities or to take necessary precautions, permit the establishment of a condition of noise pollution. In addition, all activities involving noise must also meet the standards of 310 CMR § 7.10, Air Pollution Control Regulations, as amended, which regulates outdoor noise. 7.10(1) of this regulation prohibits any person owning, leasing, or controlling a source of sound to "cause, suffer, allow, or permit unnecessary emissions from said source of sound that may cause noise." Nothing in this

bylaw prevents the Planning and Economic Development Board from attaching additional conditions relating to noise to their approval of special permit applications.

a. **Continuous Noise**. For the purposes of this bylaw, continuous noise restrictions apply to permanent non-residential installations and home-based businesses where noise is a by-product of business operations (such as from exhaust equipment). Maximum permissible sound pressure levels measured at the property line of the noise source for noise radiated continuously from the noise source between 9 P.M. and 7 A.M. shall be as follows:

Octave Band Center Frequency (Hz)	Daytime	Nighttime
63	72	67
125	60	55
250	53	48
500	47	42
1000	43	38
2000	40	35
4000	37	32
8000	33	28

Compliance with all octave band limits is required. If the enforcement officer determines that the noise source contributes significantly to ambient noise levels at a distance from the property, sound levels may be measured in those locations beyond the source property line. Noise caused by agricultural, farm-related, or forestry-related activities as defined by G.L., c 128, Agriculture, § 1A, as amended, is exempt from this restriction.

b. **Temporary Noise.** For the purposes of this bylaw, non-continuous noise restrictions apply to permanent non-residential installations and home-based businesses where noise is periodically produced. No person shall use or cause the use of any noise-producing equipment or tool (such as for construction, repair or demolition operations) between the hours of 9:00 P.M. and 7:00 A.M. The limitation of this section does not apply to any construction, demolition or repair work on public improvements authorized by a governmental body or agency. Noise caused by agricultural, farm-related, or forestry-related activities as defined by G.L., c 128, Agriculture, § 1A, as amended, is exempt from this restriction.

3. **Vibration**: No vibration which is discernible to the human sense of feeling for 3 minutes or more in any hour between 7 A.M. and 7 P.M. or of 30 seconds or more in any one hour from 7 P.M. to 7 A.M. shall be permitted. No vibration at any time shall

produce an acceleration of more than 0.1g or shall result in any combination of amplitude and frequencies beyond the "safe" range or Table 7, U.S. Bureau of Mines Bulletin NO. 442. Vibrations resulting from temporary construction activity that occurs between 7:00 A.M. and 9:00 P.M. shall be exempt from this section.

4. **Odors**: Disturbing or offensive~~Continuous, frequent, or repetitive~~ odors as defined in Paragraph A. above may not be produced in any zoning district or impact any public space where people live, work or assemble in way that unreasonably interferes with the comfortable enjoyment of life or the use of property. Nothing in this bylaw prevents the Planning and Economic Development Board from attaching additional conditions relating to odor to their approval of special permit applications.

   a. **Non-Residential Uses**. Non-residential uses that produce odors must install and maintain odor-eliminating equipment.

   ~~testing to verify compliance.~~

   ~~-~~b. **Investigation.** If the Building Commissioner/Zoning Officer determines that an investigation is warranted, an odor observation shall be undertaken to determine if an objectionable odor exists at the property line. The Building Commissioner/Zoning Officer or designated staff may use a field olfactometer to measure odor strength and~~ to~~ observe, document, verify, and enforce odor limits.~~ using a~~A measured "Dilution-to-Threshold ratio" (D/T) of seven (7) or ~~less ~~greater at the property line from where the odor is created shall constitute non-compliance with this standard. The Dilution-to-Threshold ratio is a measure of the number of dilutions needed to make the odorous ambient air non-detectable. The method of calculating D/T for the field olfactometer is:

   D/T = Volume of Carbon Filtered Air / Volume of Odorous Air

   ~~-~~Because certain odors cannot be detected by mechanical or electrical ~~means~~instruments and their odor strength cannot be effectively measured with a field olfactometer, the Building Commissioner/Zoning Officer may determine without using field devices and using only the sense of smell of the inspector that the odor is one which is objectionable to a reasonable person with normal sensitivity and that the odor source is subject to investigation, violations, penalties, and/or corrective measures.

   If the Building Commissioner/Zoning Officer determines that corrective measures are necessary, the owner and/or operator of the odor-producing use must provide the Planning and Economic Development Board with an application and plan for how the odor will become compliant for the Board's consideration of a special permit. If the Town requires consulting assistance to evaluate the application and plan, all costs will be borne by the applicant.

c. **Farming.** Odors resulting from farming practices as defined in Medway General Bylaws, c. 31, § 2, Right to Farm, are exempt.

Susan Affleck-Childs

From: Wells, Caroline <Wells.Caroline@wseinc.com>
Sent: Tuesday, May 12, 2020 2:49 PM
To: Susan Affleck-Childs
Subject: Latest version
Attachments: 2020_0512_Medway_Environmental Standards .docx; 2020_0512_Medway_Environmental Standards .pdf

Hi Susy
Attached please find the latest version of the standards, including all comments to date from Jeff Komrower, Bruce Straughan, and Barbara Saint Andre. Some notes:

- From John Lally's comments, I did use the timeframes to further define "daytime" and "nighttime" in the octave band table which just made sense.

- In terms of odor thresholds, Mr. Lally's comments and those from Bruce Straughan are not compatible. Mr. Lally's comments are correct in that the Board did prefer a quantitative measure but as Mr. Straughan notes, the language in the existing standards is not readily enforceable because they only define single compounds.

- In terms of odor investigation, I think Mr. Straughan's language gives the Building Commissioner enough latitude to investigate based on a complaint, demonstrable odor, or perceived odor:

  > *Because certain odors cannot be detected by mechanical or electrical instruments and their odor strength cannot be effectively measured with a field olfactometer, the Building Commissioner may determine without using field devices and using only the sense of smell of the inspector that the odor is one which is objectionable to a reasonable person with normal sensitivity and that the odor source is subject to investigation, violations, penalties, and/or corrective measures*.

- Mr. Lally notes the residential exception to the odor standards, and he has a point. This inclusion was based on both town staff and board comments. Perhaps this should be removed or adjusted?

Caroline

Caroline Wells, AICP
SENIOR PROJECT MANAGER / URBAN AND ENVIRONMENTAL PLANNING
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7.3. ENVIRONMENTAL STANDARDS

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B. **Enforcement**: Medway Zoning Bylaws, § 3.1, Enforcement, Violations, and Penalties authorizes the Building Commissioner to interpret and enforce this Bylaw. In addition, the police department, fire department, or board of health officials are authorized to enforce standards that are based on certain sections of 310 CMR, § 7, Air Pollution Control Regulations. At the discretion of the Building Commissioner, a technical consultant may be engaged by the Town of Medway to investigate and document violations.

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2. **Noise Disturbance:** No person or persons owning, leasing, or controlling the operation of any source or sources of noise shall willfully, negligently, or through the failure to provide necessary equipment or facilities or to take necessary precautions, permit the establishment of a condition of noise pollution. In addition, all activities involving noise must also meet the standards of 310 CMR § 7.10, Air Pollution Control Regulations, as amended, which regulates outdoor noise. Section7.10(1) of this regulation prohibits any person owning, leasing, or controlling a source of sound to "cause, suffer, allow, or permit unnecessary emissions from said source of sound that may cause noise." Nothing in this bylaw prevents the Planning and Economic Development Board from attaching additional conditions relating to noise to their approval of special permit applications.

a. **Continuous Noise**. For the purposes of this bylaw, continuous noise restrictions apply to permanent non-residential installations and home-based businesses where noise is a by-product of business operations (such as from exhaust equipment). Maximum permissible sound pressure levels measured at the property line of the noise source for noise radiated continuously from the noise source shall meet the values specified in the table below where Daytime is defined as between the hours of 7 a.m. and 9 p.m. and Nighttime defined as between the hours of 9 p.m. and 7 a.m.

Octave Band Center Frequency (Hz)	**Daytime (dB) 7:00 a.m. – 9:00 p.m.**	**Nighttime (dB) 9:00 p.m. – 7:00 a.m.**
63	72	55
125	60	48
250	53	42
500	47	39
1000	43	36
2000	40	33
4000	37	30
8000	33	27
Overall Level (dBA)	52	42

Compliance with all octave band limits is required. If the enforcement officer determines that the noise source contributes significantly to ambient noise levels at a distance from the property, sound levels may be measured in those locations beyond the source property line. Noise caused by agricultural, farm-related, or forestry-related activities as defined by G.L., c 128, Agriculture, § 1A, as amended, is exempt from this restriction when using generally accepted practices (Right to Farm Bylaw, G.L., c 111, §125A).

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4. **Odors**: Disturbing or offensive odors as defined in Paragraph A above may not be produced in any zoning district or impact any public space where people live, work or assemble in a way that unreasonably interferes with the comfortable enjoyment of life or the use of property. Nothing in this bylaw prevents the special permit granting authority from attaching additional conditions relating to odor to its approval of special permit applications.

    a. **Non-Residential Uses**. Non-residential uses that produce odors must install and maintain odor-eliminating equipment.

    b. **Investigation.** If the Building Commissioner determines that an investigation is warranted, an odor observation shall be undertaken to determine if an objectionable odor exists at the property line. The Building Commissioner or designated staff may use a field olfactometer to measure odor strength and to observe, document, verify, and enforce odor limits. A measured “Dilution-to-Threshold ratio” (D/T) of seven or greater at the property line from where the odor is created shall constitute non-compliance with this standard. The Dilution-to-Threshold ratio is a measure of the number of dilutions needed to make the odorous ambient air non-detectable. The method of calculating D/T for the field olfactometer is:

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   a. **Non-Residential Uses**. Non-residential uses that produce odors must install and maintain odor-eliminating equipment.

   b. **Investigation.** If the Building Commissioner determines that an investigation is warranted, an odor observation shall be undertaken to determine if an objectionable odor exists at the property line. ~~The Building Commissioner or designated staff may use a field olfactometer to measure odor strength and to observe, document, verify, and enforce odor limits. A measured "Dilution-to-Threshold ratio" (D/T) of seven or greater at the property line from where the odor is created shall constitute non-compliance with this standard. The Dilution-to-Threshold ratio is a measure of the number of dilutions needed to make the odorous ambient air non-detectable. The method of calculating D/T for the field olfactometer is:~~

   ~~D/T = Volume of Carbon Filtered Air/Volume of Odorous Air~~

   ~~Because certain odors cannot be detected by mechanical or electrical instruments and their odor strength cannot be effectively measured with a field olfactometer,~~ The Building Commissioner may determine ~~without using field devices and~~ using only the sense of smell of the inspector that the odor is one which is objectionable to a reasonable person with normal sensitivity and that

Commented [LJ-0-M1]: I remain puzzled as to why a violation would ever be subjected to a diluted odor observation?

I can see where D/T criteria might be appropriate in the Midwest where there is sparse population and considerable distances between odor sources and residents, which tends to result in natural dilution between sources and residents. Then yes, doing a diluted observation at the source might make sense & be representative of what residents are experiening. But for a community like Medway where the Industrial Sites are tucked in amongst neighborhoods, providing the option of doing a diluted odor observation just makes odor compliance and enforcement very confusing and risks exposing residents to objectionable odors.

As near as I can tell the existing Medway ZBL intends to limit objectionable odors to the Undiluted Detection Threshold. Providing an option to observe odors diluted by a factor of 7 isn't just an upgrade to modern standards, it seriously erodes the odor protections that were intended for Medway residents. It's my understanding that erosion of existing protections were not the intention of the environmental standard updates. In order for Medway residents to maintain the odor protections that were intended for them, a diluted odor observation should not be an option duing the investigation.

The language following the D/T criteria provides for the Building commissioner to make determinations only using their undiluted natural sense of smell, why wouldn't that always be the way determinations are made, i.e. undiluted observations? After all given the close proximity of Industrial Facilites to Medway Residents that's more representative of what residents experience. It has the added benefit of the Town not having to buy field olfactomoter and train Town Staff in there use.

Even with the D/T criteria deleted the subjective quality of what remains, leaves me troubled. I might be able to find my way to supporting and voting for this with the D/T deleted, but that remains unclear.

the odor source is subject to investigation, violations, penalties, and/or corrective measures.

If the Building Commissioner determines that corrective measures are necessary, the owner and/or operator of the odor-producing use must provide the special permit granting authority with an application and plan for how the odor will become compliant for the special permit granting authority's consideration of a special permit. If the Town requires consulting assistance to evaluate the application and plan, all costs will be borne by the applicant pursuant to G.L. c. 44, § 53G.

c. **Farming.** Odors resulting from farming practices as defined in Medway General Bylaws, c. 31, § 2, Right to Farm, are exempt from this restriction when using generally accepted practices (Right to Farm Bylaw, G.L., c 111, §125A).