Cannabis Control Commission
COMMONWEALTH OF MASSACHUSETTS

11/17 Public Meeting Book - Cannabis Control Commission Public Meeting

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New Business Not Anticipated at the Time of Posting

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20261117 Public Meeting Presentation

Cannabis Control Commission
COMMONWEALTH OF MASSACHUSETTS

November 12, 2026

In accordance with Sections 18-25 of Chapter 30A of the Massachusetts General Laws and Chapter 2 of the Acts of 2023, notice is hereby given of a meeting of the Cannabis Control Commission. The meeting will take place as noted below.

CANNABIS CONTROL COMMISSION

November 17, 2026
10:00 AM

Remote via Microsoft Teams*

PUBLIC MEETING AGENDA

I. Call to Order
II. Commissioners' Comments & Updates
III. Staff Recommendations on Final Licenses
    1. Responsible and Compliant Southwick LLC (#MR285245)
IV. Commission Discussion and Votes
    1. Chapter 65 Fall Regulatory Round Policy Discussion
    2. Discussion on Drive Throughs at Marijuana Establishments
    3. Discussion of Study and Recommendations Regarding the Effective Regulation of the Hemp-Derived Cannabinoid Market in Massachusetts
V. Executive Session
    The Commission may enter closed executive session under G. L. c. 30A, § 21(a)(3) to discuss strategy with respect to collective bargaining or litigation because the open meeting may have a detrimental effect on the bargaining or litigating position of the public body.
VI. New Business Not Anticipated at the Time of Posting
VII. Next Meeting Date
VIII. Adjournment

*Closed captioning available

If you need reasonable accommodations in order to participate in the meeting, contact the Commission's ADA Coordinator Sudeshna Chatterjee at ADACompliance@cccmass.com in advance of the meeting. While the Commission will do its best to accommodate you, certain accommodations may not be available if requested immediately before the meeting.

Cannabis Control Commission
COMMONWEALTH OF MASSACHUSETTS

Responsible and Compliant Southwick LLC

MR285245

ESTABLISHMENT OVERVIEW

1. Name and address of the Marijuana Establishment:

Licensee Business Name:	Responsible and Compliant Southwick LLC
Licensee d/b/a Name:	HAVEN
Licensed Location:	681 College Hwy, Southwick, MA 01077

2. Type of final license sought (if cultivation, its tier level and outside/inside operation):

License Type(s) Sought:
Marijuana Retailer

3. List of all required individuals and their roles:

Individual	Role	Ownership Percentage	Control Percentage
Mark Dupuis	Person Having Direct/Indirect Control	51%	100%
Brian Kuchachik	Person Having Direct/Indirect Control	10%	0%
Michael Simonian	Person Having Direct/Indirect Control	20%	0%
Mark Simonian	Person Having Direct/Indirect Control	19%	0%

4. List of all required entities and their roles:

Entity	Role	Ownership Percentage	Control Percentage
Haven #7 LLC	Capital Contributor	0%	0%
The Airport Collective Inc	Capital Contributor	0%	0%
Haven #1 LLC	Capital Contributor	0%	0%
Maywood Green Solutions, LLC	Capital Contributor	0%	0%
Pure San Bernardino, LLC	Capital Contributor	0%	0%

Next Gen Enterprises LLC	Capital Contributor	0%	0%

5. The licensee and associated owners are associated with the following license type(s):

   The licensee is not associated with any other licenses.

LICENSING OVERVIEW

6. The licensee was approved for provisional licensure for the above-mentioned license(s) on July 10, 2025.

7. The licensee has paid all applicable license fees.

8. No new information has been reported to Commission staff regarding the organizational structure of the entity since the issuance of the provisional license(s).

9. No new information has been discovered by Commission staff regarding the suitability of the licensees previously disclosed since the issuance of the provisional license(s).

INSPECTION OVERVIEW

10. Commission staff inspected the licensee's facility on the following date(s): November 4, 2026.

11. The licensee's facility was inspected by Commission staff and found to be in full compliance with the requirements listed in 935 CMR 500.105 through 935 CMR 500.160 as applicable.

12. No evidence was discovered during the inspection(s) that indicated the licensee was not in compliance with all applicable state laws and local bylaws or ordinances.

13. Specific information from Commission staff's inspection is highlighted below:

    a. Security

    Enforcement staff verified that all security-related requirements were in full compliance with Commission regulations. Some of the requirements verified include the following:

    i. The security of all entrances and exits;
    ii. Visitor procedures;
    iii. Limited access areas;
    iv. Verification of a primary and back-up security company;
    v. Presence of perimeter and duress alarms; and
    vi. All cameras complied with Commission requirements.

b. Inventory and Storage

Enforcement staff verified that all inventory-related requirements were in full compliance with Commission regulations. Some of the requirements verified include the following:

i. Secure storage of marijuana and marijuana products;
ii. Sanitation and pest control measures; and
iii. Inventory controls and procedures.

c. Retail Operation

Enforcement staff verified that all retail-related requirements were in full compliance with Commission regulations. Some of the requirements verified include the following:

i. Verification of identifications for access;
ii. Layout of the sales floor; and
iii. Availability and contents of adult-use consumer education materials.

d. Transportation

The licensee will not be performing transportation activities at this time.

FINAL LICENSE CONDITIONS

Commission staff has reviewed the license for compliance with applicable laws and regulations and are presenting it for the Commission's review and vote.

1. The licensee may possess and otherwise acquire marijuana, but shall not dispense, sell, or otherwise transport marijuana to other Marijuana Establishments, or to consumers, until upon inspection, receiving permission from the Commission to commence full operations.
2. The licensee is subject to inspection to ascertain compliance with Commission regulations.
3. The licensee remains suitable for licensure.
4. The licensee shall cooperate with and provide information to Commission staff.
5. Licensure is subject to notification to the Commission of any update to written operations plans required by 935 CMR 500.105(1) prior to the issuance of a commencement of operations and that Commission staff be given adequate opportunity to review said plans at the business location or the location where any such plans are maintained in the normal course of business.

The licensee has demonstrated compliance with the laws and regulations of the Commonwealth and suitability for licensure. Therefore, the licensee is recommended for final licensure.

As part of the approval of final licensure, the Commission authorizes staff to take all necessary actions to review compliance with the above-referenced conditions and to approve the commencement of operations.

Cannabis Control Commission
COMMONWEALTH OF MASSACHUSETTS

Marijuana Retailer Post-Provisional License Inspection Report

License(s) Inspected:	Responsible and Compliant Southwick dba Haven
Address:	681 College Highway Southwick, MA 01077
License Type(s):	Adult Use Retail MR285245
Date of Inspection(s):	November 4, 2026
Report of:	Jenn Rogers

1. On 7/10/26, the above-captioned establishment, Responsible and Compliant Southwick dba Haven (Licensee), was granted a Provisional License by the Commission.

2. The Persons Having Direct/Indirect Control and/or Entities Having Direct/Indirect Control in the License as disclosed to the Commission are as follows: (List all)

Persons Having Direct/Indirect Control	Entities Having Direct/Indirect Control
Mark Dupuis Brian Kuchachik Michael Simonian Mark Simonian	

3. On 11/4/26, ES conducted a Post-Provisional License Inspection of the establishment and attests to the following requirements of the Post-Provisional License Inspection:

Initial	Requirement
JR	1. The Licensee's Host Community Agreement (HCA)/ Host Community Agreement (HCA) Waiver held between the Licensee and its Host Community was reviewed by Commission staff and appeared compliant with 935 CMR 500.180.
JR	2. The Licensee received its Certificate of Occupancy from the Host Community on 10/13/26.
JR	3. The Licensee has confirmed all applicable Responsible Vendor Training Basic Core Curriculum will be provided by Bartucca Consulting, LLC and will be completed prior to performing job functions.
JR	4. The Licensee supplied ES with copies of full standard operating procedures (SOPs) pursuant to 935 CMR 500.105(1)(a-r), 935 CMR 500.110, and those procedures specific to the license type as detailed in 935 CMR 500.140. All documents were reviewed by ES.
JR	5. The Licensee provided ES with a copy of the certificate of liability insurance demonstrating coverage compliant with 935 CMR 500.105(10).
JR	6. The Licensee indicated that it had shared its security plan with Law Enforcement. ES contacted local Law Enforcement on 10/26/26 to confirm receipt of the security plan and that there were no outstanding issues with the Licensee.
JR	7. ES observed that the Licensee had established Limited Access Areas pursuant to 935 CMR 500.110.
JR	8. ES observed the Licensee's Security and Alarm Requirements pursuant to 935 CMR 500.110(5).
JR	9. ES reviewed the Licensee's policies and procedures related to its Cash Handling and Transportation pursuant to 935 CMR 500.110(7) and 935 CMR 500.110(8), as applicable. The Licensee is banking with Baycoast Bank.

JR	10. ES reviewed the Licensee's policies and procedures related to its Inventory pursuant to 935 CMR 500.105(8) and 935 CMR 500.110 and observed the Licensee's secured storage areas.
JR	11. The Licensee will monitor inventory using the Commission's seed-to-sale system of record, Metrc. The Licensee will utilize a secondary tracking system and point-of-sale system called Dutchie.
JR	12. The Licensee will limit access to those 21 years of age or older through inspecting Consumer's government-issued identification upon entry to the Premises and at the point-of-sale.
JR	13. ES reviewed the Licensee's policies and procedures related to its wasting activities pursuant to 935 CMR 500.105(12). The Licensee will be utilizing USA Waste and Recycling for trash removal.
JR	14. Option 2 Option 2: The Licensee will rely upon its wholesale partners, and/or Marijuana Transporters for its product transportation needs. The Licensee will comply with requirements pursuant to 935 CMR 500.105(13) as applicable.
JR	15. ES reviewed the Licensee's advertising and marketing practices for compliance with 935 CMR 500.105(4).
JR	16. Option 1 Option 1: The Commission placed no additional conditions at the time of Provisional Licensure.

JR	17. Option 2 Option 2: There were no deficiencies identified during this inspection.
JR	18. The employee attests that all information contained within this report is accurate and complete to the best of their knowledge, and that all supporting documentation and information related to the inspection is contained within the case management system record.

Based upon the observations of ES during the Post-Provisional License Inspection, this establishment is recommended for Final License.

Employee Name: Jenn Rogers

Title: Investigator

Signature: Jenn Rogers

Fee Refund Policy

Policy Number:	**Revision Dates:** 05/04/2021
200.03	**Review Dates:**

Approval Signatures:

Alisa Stack — Digitally signed by Alisa Stack Date: 2022.01.03 14:12:45 -05'00'	Shawn Collins — Digitally signed by Shawn Collins Date: 2022.02.16 14:56:06 -05'00'
Alisa Stack, COO **Policy Owner**	Shawn Collins, Executive Director **Executive Approval**

Purpose:
This policy states the Commission's approach to refunds for fees, including application fees, licensing fees, renewals, penalties, marijuana establishment agents, registered patients, and caregivers.

Audience:
This policy is for use by all Commission staff.

Definitions:
N/A

Legal References:
N/A

Associated Procedures:
N/A

Policy:
All fees paid to the Commission are final. The Commission does not reimburse application fees. The Commission will return payment in three circumstances:

- Double payment;
- Paid incorrect amount; or
- Submitted payment in error.

In the event of these circumstances, the Director of Licensing or the Constituent Services Director will provide the approval and proper documentation to the Fiscal Specialist. The Director of Licensing is responsible for tracking payment of licensing fees and reconciling payments with the Fiscal Specialist. The Constituent Services Director is responsible for tracking payment of replacement cards and reconciling payments with the Fiscal Specialist. The Chief Financial and Accounting Officer authorizes any return of a payment in the above circumstances once all reconciliation and records are complete.

Cannabis Control Commission
COMMONWEALTH OF MASSACHUSETTS

Memorandum

To:	Travis Ahern, Executive Director
Cc:	Andrew Carter, Chief of Staff
	Armond Enos, Director of Enforcement Training
	Kajal Chattopadhyay, General Counsel
	Mike Baker, Deputy General Counsel
	Roque Rosa, I&E EA
	Abigael Vogt, Executive Assistant
From:	Olivia Koval, Director of Licensing
	Tim Goodin, Enforcement Counsel
Date:	August XX, 2026
Subject:	Late Submission of Renewal Applications – FOR ACTION
Importance:	**Expedite**

PURPOSE: Propose options to address the late submissions of License renewal applications.

REQUEST ACTION BY: At ED convenience.

BACKGROUND: Pursuant to 935 CMR 500.103(4)(a) and 501(4)(a), "No later than 90 calendar days prior to the expiration date, a Marijuana Establishment shall submit a completed renewal application to the Commission in a form and manner determined by the Commission, along with the required license fee." To support compliance, the Commission currently issues automated renewal reminders beginning 180 days prior to license expiration, and the renewal application becomes available in the MassCIP portal 120 days prior to expiration.

Despite these requirements, Licensees frequently submit renewal applications after the 90-day deadline, sometimes within weeks or days of expiration. This practice places significant operational strain on the Licensing division and the Commission as a whole, requiring expedited review and emergency recommendation to the Executive Director to prevent license expiration and disruption of the Licensee's operations. This reactive process strains the Commission's resources, undermines orderly regulatory review, and creates inequities among licensees who comply with established timelines.

RECOMMENDATION:

To address this issue, the Commission may: (1) establish a late application fee through regulatory amendment; or (2) assess a fine for non-compliance with 935 CMR 500.103(4)(a) or 501.103(4)(a), as applicable.

1. Late Submission Fee

To address this issue, the Commission should direct staff to revise regulations of 935 CMR 500.005 and 501.005 at the next amendment cycle to adopt a formal late renewal fee structure for renewal applications submitted after the regulatory deadline but before the expiration of the license, as well as for renewal applications submitted during any post-expiration grace period established by regulation. Applications submitted within 30 days of expiration would include explicit notice that the Commission cannot guarantee timely review prior to expiration.
The Commission could adopt an administrative late fee structure as listed below.

License Type	**Annual License Fee**	**10% Additional Fee (89 – 61 days from expiration)**	**30% Additional Fee Assessment (60> days from expiration)**
Medical Marijuana Establishment	$50,000	$5,000	$10,000
Marijuana Cultivator (Indoor or Outdoor) Tier 1 Tier 2 Tier 3 Tier 4 Tier 5 Tier 6 Tier 7 Tier 8 Tier 9 Tier 10 Tier 11	 $1,250 (I) / $625 (O) $2,500 (I) / $ 1,250 (O) $5,000 (I) / $2,500 (O) $20,000 (I) / $10,000 (O) $22,500 (I) / $11,250 (O) $25,000 (I) / $12,500 (O) $30,000 (I) / $15,000 (O) $35,000 (I) / $17,500 (O) $40,000 (I) / $20,000 (O) $45,000 (I) / $22,500 (O) $50,000 (I) / $25,000 (O)	 $125 (I) / $62.50 (O) $250 (I) / $125 (O) $500 (I) / $250 (O) $2,000 (I) / $1,000(O) $2,250 (I) / $1,125 (O) $2,500 (I) / $1,250 (O) $3,000 (I) / $1,500 (O) $3,500 (I) / $1,750 (O) $4,000 (I) / $2,000 (O) $4,500 (I) / $2,250 (O) $5,000 (I) / $2,500 (O)	 $250 (I) / $125 (O) $500 (I) / $250 (O) $1,000 (I) / $500 (O) $4,000 (I) / $2,000 (O) $4,500 (I) / $2,250 (O) $5,000 (I) / $2,500 (O) $6,000 (I) / $3,000 (O) $7,000 (I) / $3,500 (O) $8,000 (I) / $4,000 (O) $9,000 (I) / $4,500 (O) $10,000(I) / $5,000 (O)
Marijuana Product Manufacturing	$10,000	$1,000	$2,000
Independent Testing Laboratory	$10,000	$1,000	$2,000
Marijuana Retailer	$10,000	$1,000	$2,000
Social Consumption Establishment: Supplemental On-site Consumption	$5,000	$500	$1,000

Social Consumption Establishment: Hospitality On-site Consumption	$5,000	$500	$1,000
Social Consumption Establishment: Marijuana Event Organizer	$5,000	$500	$1,000
Marijuana Transporter: Third-party Transporter	$5,000	$500	$1,000
Marijuana Transporter: Existing Licensee Transporter	$5,000	$500	$1,000
Marijuana Courier	$5,000	$500	$1,000
Marijuana Delivery Operator	$10,000	$1,000	$2,000
Marijuana Establishment with a Delivery Endorsement	$5,000	$500	$1,000
Marijuana Research Facility	$1,000	$100	$200

If Licensees submit their renewal application after the license has already expired, they would incur a 50% additional fee as long as the application is submitted withing the approved post-expiration window.

a. Compliance History Impact

Late renewal submissions could be documented as regulatory violations perhaps by way of Notices of Deficiency. These documented violations would be considered during future renewal reviews if they submit late again and perhaps for enforcement escalation if the violations continue.

2. Strict Renewal Deadline

Alternatively, we could adhere to the strict submission deadline outlined in 935 CMR 500.103(4)(a)[3] after which renewal applications would no longer be accepted, ultimately rendering the license expired and requiring the Licensee to start an application from scratch to become licensed again. However, this approach is considerably more restrictive, as it would effectively eliminate a licensee's ability to renew 90 days before the license expiration date, even though the license itself would remain valid during that period. This could create confusion an undermined the distinction between a renewal submission deadline and the actual license expiration date.

RECOMMENDATION:

EXECUTIVE DIRECTOR DECISION:

☐ Approve
☐ Disapprove
☐ Edit and resubmit
☐ Need more information _____

[3] 935 CMR 500.103 (4)(a) states: "No later than 90 calendar days prior to the expiration date, a Marijuana Establishment shall submit a completed renewal application to the Commission in a form and manner determined by the Commission, as well as the required license fee".

Cannabis Control Commission
COMMONWEALTH OF MASSACHUSETTS

Memorandum

To:	Travis Ahern, Executive Director
Cc:	Andrew Carter, Chief of Staff Armond Enos, Interim Co-Chief of Investigations and Enforcement Kajal Chattopadhyay, General Counsel Mike Baker, Deputy General Counsel Roque Rosa, I&E EA Abigael Vogt, Executive Assistant
From:	Olivia Koval, Director of Licensing Tim Goodin, Interim Co-Chief of Investigations and Enforcement
Date:	August XX, 2026
Subject:	Renewal Window for Expired Provisional Licensees– FOR ACTION
Importance:	**Routine**

PURPOSE: Request Executive Director (ED) approval to bring before the Commission a recommendation to direct staff to incorporate a renewal application deadline into 935 CMR 500.103 and 501.103 at the next regulatory amendment cycle.

REQUEST ACTION BY: At ED's convenience.

BACKGROUND:

Under 935 CMR 500.103(4) and 935 CMR 501.103(4), a Licensee "shall submit a completed renewal application no later than 90 calendar days prior to the expiration of the license." The regulations and the enabling statute are silent as to whether a renewal application may be accepted after a license has expired.

In practice, the Licensing Division has accepted renewal applications from Licensees after expiration. For provisional Licensees in limited instances renewal applications were accepted up to approximately one-year post-expiration. Because provisional Licensees are licensed but not yet operational, expiration results in no operational disruption. In essence, a provisional Licensee can allow its license to lapse, avoid the annual renewal fee for the lapsed period, and later renew the license at a time of its choosing. This effectively converts the annual renewal fee into an optional payment for non-operational licensees and treats late-renewing Licensees more favorably than those who renew on time.

This recommendation applies to provisional Licensees only. Expired final licenses are considered under 935 CMR 500.415 and 501.415. ("A Marijuana Establishment license is void if the Marijuana Establishment ceases to operate…."). This recommendation effectively mirrors the 60-day standard used to assess whether an operational licensee has ceased to operate.

RECOMMENDATION:

1. **60 Day Window**

To address this issue, the Commission should direct staff to revise the regulations outlined in 935 CMR 500.103 and 501.103 at the next amendment cycle to require a 60-day post-expiration period during which the licensee must complete the renewal process and obtain approval. If the renewal is not approved within that period due to the licensee's failure to submit the required documentation, respond to Requests for Information (RFIs), or otherwise satisfy renewal requirements, the provisional license would no longer be eligible for renewal, and the applicant would be required to restart the licensing process.

Importantly, the 60-day period should not be satisfied merely by submitting a renewal application. Otherwise, licensees could submit incomplete applications near the end of the period and then take several additional months to respond to RFIs, effectively circumventing the intended deadline.

Consideration should be given to circumstances where the licensee has timely satisfied all outstanding requirements, but approval remains pending solely due to Commission processing delays.

A license for which a complete renewal application is not received and approved within that window would no longer be eligible for renewal, and the former Licensee would be required to submit a new application for licensure, subject to all requirements, fees, restrictions, and priority rules in effect at the time of the new application. Importantly, this 60-day period does not extend the term of the license or authorize any licensed activity; rather, it establishes the period during which the Commission will accept a renewal application following expiration.

The 60-day period is based on the Commission's existing regulatory framework to determine whether a Licensee has ceased to operate. The definition of "Ceases to Operate" in 935 CMR 500.002 and 501.002 considers 60 days of inactivity "with no substantial action taken to reopen" as the point at which an establishment's closure becomes regulatorily significant. Adopting the same 60-day benchmark for lapsed provisional licenses maintains internal consistency—the Commission would apply a single, uniform measure of the period after which inaction is treated as abandonment of licensed status.

2. **Strict Expiration Date**

Alternatively, the Commission could consider amending its regulations to explicitly provide that licensees who fail to submit a renewal application and obtain approval prior to their license expiration date would no longer be eligible for renewal and would instead be required to restart the licensing process.

This approach would establish a clear and consistent deadline, eliminate the potential for prolonged renewal proceedings after expiration, and reduce the need for discretionary good-cause determinations. However, consideration should be given to situations where approval is delayed due to circumstances outside the licensee's control, including Commission processing delays.

EXECUTIVE DIRECTOR DECISION:

☐ Approve
☐ Disapprove
☐ Edit and resubmit
☐ Need more information _____



August 10, 2015

Marijuana Equivalency in Portion and Dosage

An assessment of physical and pharmacokinetic relationships in marijuana production and consumption in Colorado

Prepared for the Colorado Department of Revenue

The authors are grateful for suggestions and assistance from Lewis Koski, Ron Kammerzell, Jim Burack, Dr. Franjo Grotenhermen, M.D., Dr. Kari Franson, M.D., and all the businesses that hosted the team and contributed information to this study. Any omissions or errors are the sole responsibility of the report team.

This report was commissioned under Colorado HB 14-1361. The Colorado Department of Revenue retained the University of Colorado, Leeds School of Business, Business Research Division, in partnership with the Marijuana Policy Group, and BBC Research & Consulting, to produce an unbiased and scientific report for the purpose of rulemaking by Colorado stakeholders.

Version 12 / August 10, 2015

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Marijuana Equivalency in Portion and Dosage

An assessment of physical and pharmacokinetic relationships in marijuana production and consumption in Colorado

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Executive Summary

The original legislation to legalize and regulate marijuana in Colorado does not explicitly restrict marijuana concentrates and infused edibles. Over time, these marijuana products have become more popular, prompting new legislation to remedy the omission. House Bill 14-1361 now stipulates limits upon marijuana flower portions, "or their equivalent."

This study provides scientific and data driven evidence in order to understand these equivalencies. The results provide comparisons between marijuana flower, concentrates and infused products specifically for Colorado's marijuana market.

Equivalency can be viewed from three perspectives: production, dosing, and market price. The first perspective relates to physical production, where infused edibles or concentrates are traced back into their corresponding weight of flower or trim inputs. This enables the conversion from non-flower products into a common flower-based denominator, so that aggregate use can be measured across different marijuana product types.

The second perspective uses pharmacology to develop a dose-equivalent measure across product types. The results equate the dosing effects between inhaled and ingested marijuana products. Finally, the third perspective uses Colorado potency and market data to convert marijuana retail prices into their unit-THC equivalents. These THC-based prices are then compared across product types. A powerful and reassuring finding is that Colorado's market prices reflect, almost identically, the dosing equivalencies found in the pharmacological review. The pricing perspective is a new methodology, made possible by analyzing recently collected data from Colorado's retail marijuana market.

The information contained in this report is specific to Colorado in 2015. Production techniques are constantly evolving, and the marijuana included in this study was grown in Colorado and may not share similarities with product in other regions. Overall, the study is designed to meet the requirements of Colorado House Bill 14-1361 and focuses solely on the retail adult-use marijuana market in Colorado.

PHYSICAL EQUIVALENCY

Physical equivalencies were calculated in two ways – a THC equivalency, and a physical production equivalency. Physical equivalencies were calculated for the major concentrate and infused product manufacturing techniques, including butane hash oil, CO_2 oil, ethanol, and water. Physical production equivalency is calculated by isolating the marijuana trim and shake inputs and determining a yield ratio. The THC methodology provides an equivalent amount of THC in various forms of marijuana products based on recent state testing information Table ES-1 shows equivalency factors for both methodologies by solvent type.

The physical equivalencies in Table ES-1 show that between 347 and 413 edibles of 10mg strength can be produced from an ounce of marijuana, depending on the solvent type and production method. For concentrates, between 3.10 and 5.50 grams of concentrate are equivalent to an ounce of flower marijuana.

The THC equivalency factors in Table ES-1 can be interpreted as showing units with equivalent amounts of THC based on recent state testing data. For instance, given the uniform dosage amounts of edibles in Colorado,434 edibles of 10mg strength and one ounce of flower marijuana at average potency have an equivalent amounts of THC. For concentrates, between 6.91 and 8.50 grams of concentrate (depending on solvent) and an ounce of flower marijuana at average potency have an equivalent amount of THC.

Table ES-1. One Ounce Equivalents by Solvent Type

	1-Ounce Flower Equivalents			
	Physical Equivalency		THC Equivalency	
	Amount	Amount	Amount	Amount
	Edibles	Concentrate (g)	Edibles	Concentrate (g)
Solvent Type	(10mg)	(Avg. Potency)	(10mg)	(Avg. Potency)
Butane	391.07	5.46	434.35	6.91
CO2	346.96	4.84	434.35	8.07
Butter/Lipid	413.49	N/A	434.35	N/A
Ethanol	N/A	5.44	N/A	7.37
Water	N/A	3.10	N/A	8.50

Source: Author calculations based on metrc™ data.

The conversion factors described above are the first of their kind. They can be useful for state-level production management. The conversions allow units of infused edibles and concentrates to be denominated by flower weight, and then added to flower sales, in order to determine retail market demand and supply.

PHARMACOKINETIC EQUIVALENCY

An important compliment to the physical THC relationships identified in this study is the pharmacological perspective. If the purpose of the equivalency legislation is to limit transactions or possession to a reasonable "dose" of concentrates and marijuana products for residents and non-residents, then the medical effects described here will be useful to construct a set of equivalencies between marijuana product types.

Pharmacokinetic equivalency incorporates findings from medical and pharmacological publications to inform marijuana stakeholders about the dosing process. The authors created a new mathematical construct that can compare ingested and smoked marijuana products in a consistent manner.

The pharmacokinetic model compares inhaled and ingested products using a dose ratio. The calculations are based upon different uptake routes and speeds for the psychoactive compounds related to marijuana use (e.g., THC and 11-OH-THC). Other compounds, such as cannabinoids, are not included here because the legislation relates only to retail use. The base pharmacokinetic equivalency ratio is 1 to 5.71. This means that one milligram of THC in edible form, is equivalent to 5.71 milligrams of THC in smokable form.

Table ES-2. Pharmacokinetic Dosage Equivalency

	Average THC Potency	Effective Uptake Ratio	1 Gram Equivalent	1 Ounce Equivalent
Buds/Flower	17.1%	1.00	1 Gram	1 Ounce
Edibles	N/A	5.71	3 Servings	83 Servings
Concentrates	62.1%	1.00	0.28 Grams	7.72 Grams

Source: Author calculations based on metrc™ data.

Table ES-2 shows the pharmacokinetic equivalencies, and the corresponding serving equivalencies, using data from Colorado.

Pharmacokinetic equivalencies indicate that 83 ten-milligram infused edible products is equivalent to one ounce of marijuana flower in Colorado. About 7.72 grams of concentrate is equivalent to an ounce of flower marijuana.

MARKET PRICE EQUIVALENCY

For comparison, a third equivalency approach was developed by the study team. This is the "market price equivalency" method. As with the physical equivalencies, this methodology was previously not possible. We use metrc™ data to convert retail store market prices into a price per unit of THC across different products. These new THC-based prices reflect the inherent value of each product from a psychoactive dose viewpoint. They reveal the price that consumers are willing to pay for the psycho-active experience (the high) yielded from each type of product.

Table ES-3 below shows representative marijuana product pricing in Colorado's retail market. The top portion shows typical prices for the products themselves. The middle portion shows the price after conversion—in cents per milligram THC (¢/MG_{THC}). Finally, the bottom portion computes the price-ratio between products using the THC price measure.

Table ES-3 shows the price of marijuana flower, or buds, is $14.03 when purchased by the gram, or $264 when an ounce is purchased. When converted to THC, the same product costs 8.25 cents per milligram THC when purchased by the gram, and 6.10 ¢/MG_{THC} for an ounce, reflecting some volume-pricing. Similarly, a typical 100mg THC edible product costs $24.99, a 40mg product is $19.81, and a single-serve 10mg THC edible costs $6.60. When converted, the THC price for these products equals 24.99 ¢/MG_{THC}, 35.00 ¢/MG_{THC}, and 66.00 ¢/MG_{THC} respectively, for these goods. Finally, concentrates cost $55.00 for a typical 1 gram wax portion, and a typical 500mg vaporizing cartridge costs $66.00. The THC prices are 8.46 ¢/MG_{THC} and 18.86 ¢/MG_{THC}, respectively.

Using the THC prices, the edibles to flower price ratio is 3.03 (edible THC per flower THC) for the 100mg edible product, 3.00 for the 80mg product, and 4.24 for the 40mg product. The 10mg single-serving ratio is 8.00, which we believe reflects a minimum price for small portions.

The ratio for wax/shatter is 1.03 for a 1 gram container, and 2.28 for a 500mg vaporizer cartridge. The higher price ratio for vaporizing equipment may reflect higher packaging costs.

In general, the price ratios shown in Table ES-3 are notable because they match—quite closely—to the pharmacokinetic equivalency ratios. This means that although the market participants may not have completed their own pharmacokinetic research, they naturally have gravitated toward this result, based simply upon trial and error.

The remainder of this report provides details regarding the data, the methodologies, and previous scientific findings used to construct our results.

Table ES-3. THC Market Price Equivalencies

THC Market Price Ratios in Colorado					
Indicative Prices by Weight ($)					
Buds/Flower		1 Gram	1/8 Oz	1/4 Oz	1 Ounce
	Most Common	$14.03	$41.27	$82.54	$264.14
	Discounted	$12.38	$33.03	$66.06	$239.43
Edibles		100 MG	80 MG	40 MG	10 MG
	Edible Variety	$24.99	$19.81	$14.00	$6.60
Concentrates		1 Gram	500 MG	250 MG	
	Wax / Shatter	$55.00	--	--	--
	Vape Cartridge	--	$66.00	$46.00	--
Equivalent Market Price (Cents per MG THC)					
Buds/Flower		1 Gram	1/8 Oz	1/4 Oz	1 Ounce
	Most Common	8.25	6.94	6.94	6.10
	Discounted	7.28	5.55	5.55	5.53
Edibles		100 MG	80 MG	40 MG	10 MG
	Edible Variety	24.99	24.76	35.00	66.00
Concentrates		1 Gram	500 MG	250 MG	
	Wax / Shatter	8.46	--	--	--
	Vape Cartridge	--	18.86	26.29	--
THC Market Price Equivalencies (Price Ratios in THC Units)					
Buds/Flower		1 Gram	1/8 Oz	1/4 Oz	1 Ounce
	Most Common	1.00	1.00	1.00	1.00
Edibles		100 MG	80 MG	40 MG	10 MG
	Edible Variety	3.03	3.00	4.24	8.00
Concentrates		1 Gram	500 MG	250 MG	
	Wax / Shatter	1.03	--	--	--
	Vape Cartridge	--	2.28	3.19	--

Note: 1. Prices taken from a sample of online retail menus for Colorado stores.
2. Ratios may not necessarily apply to other states..

Source: Colorado Storefront menus, calculations by the report study team.

Overview and Motivation

The original legislation to legalize and regulate marijuana in Colorado for adult use did not include explicit purchase restrictions on marijuana concentrates and infused edibles. As these marijuana products grew more popular in 2014, up to 35 percent[1] of statewide retail sales, legislation was enacted under House Bill 14-1361 to remedy the omission. The legislation does so by stipulating limits upon marijuana flower portions, "or their equivalent."

This study provides unbiased, scientific information that can be used to suggest appropriate equivalencies between flower and alternative marijuana products. It is a summary of how different marijuana products are produced and consumed in accordance with House Bill 14-1361, which requires the state to conduct a study to establish equivalencies.

The information in this study can be used to convert concentrate and infused products into their flower weight equivalents from both a production and consumption viewpoint. From a production viewpoint, the findings can be used to translate marijuana product unit sales into their weight equivalent. This will improve the measurement of aggregate marijuana demand, by using a common denominator. From a consumption viewpoint, the findings here can be used to establish an equivalent "dose" amount between non-flower products and flower weight. Overall, the study is designed to meet the requirements of House Bill 14-1361 and focuses solely on the retail adult-use marijuana market. Issues related to medical marijuana are not addressed in this study.

PRODUCTION, PRICE, AND DOSING EQUIVALENCIES

This study investigates marijuana equivalencies from three perspectives: production, price, and dosing.

The first perspective is from a physical production viewpoint, where servings of infused edibles or concentrates are converted into the respective weight of marijuana flower or trim needed as inputs to production. To construct these equivalencies, average yield and potency is estimated by the consultants after a series of interviews with Marijuana Infused Product (MIP) manufacturers, and by analyzing the state's Marijuana Enforcement Tracking Reporting Compliance (metrc™) database to isolate input and output packages at MIPs for various concentrates and infused edibles. This metric will provide a bridge between concentrate and infused edible output and plant material inputs.

The second perspective computes equivalencies from a dosing viewpoint. The dosing perspective provides stakeholders with a pharmacological model that equates the dosing effect between inhaled and ingested marijuana products. The pharmacological approach resolves the disparity between weight-based THC content in marijuana products, so that a dose-equivalent measure can be established.

Finally, the third perspective computes the market price of THC across product types in the Colorado marketplace. The pricing perspective is a new methodology. It was made possible by manipulating recently collected data from Colorado's retail marijuana market. By using statewide inventory and testing data, the study team can convert retail marijuana store price for flower, concentrates, and infused edibles into a price with a common denominator—THC. The study team found that the pricing structure in stores reflects, almost exactly, the pharmacokinetic dosing equivalencies found in this report. This suggests that although no individual has explicitly measured the dosing effect of different products, that the marketplace reflects the dosing value for each product implicitly.

1 Based upon statewide retail sales, May – September 2014.

The science and data related to marijuana, its use, and regulation are inherently complex. The purpose of this report is to synthesize state-level marijuana data with existing manufacturing and medical research in order to construct easy-to-understand ratios between marijuana product types. The resulting information can be used to establish a set of rules that are defensible, operable, transparent and systematic. Over time, as new information evolves, these findings may be reviewed and adjusted to reflect the most current research available.

This analysis and report is developed for use by stakeholders in Colorado's retail marijuana market. It is assumed that the reader of this report is an informed, intelligent public policy official or individual with experience and understanding of Colorado's retail and medical marijuana markets. The objective of this report is to provide a clear and understandable synthesis of relationships between marijuana product types.

USE OF METRC™ DATA

This study would not have been possible before the state inventory tracking system was established. The system allows a viewpoint of the entire state marketplace from "seed to sale", providing a powerful data arena from which to determine key statistics, such as potency levels, production ratios, and consumption rates, to name a few. Colorado's inventory tracking platform, metrc™, requires data to be uploaded from every cannabis business. As a result, there is some underlying variability due to user input error by MIPs, cultivations, and retail stores.

During this study and during previous studies over the past 18 months, the study team has reconciled most disparities by conducting thorough checks, and through vendor interviews to ensure that data is being interpreted correctly. Over the course of this research, the investigators applied generally accepted statistical methods to remove outliers and questionable records. The sample sizes used in the analysis represent the largest samples we could pull from the system that we believed would give reliable results.

The report is organized as follows: Section II provides a summary of prevailing MIP production techniques, followed by the calculation of production equivalencies in Section III. In Section IV, a pharmacokinetic model is developed and dosing equivalencies are defined. Section V explains the market price equivalency methods and findings, and Section VI provides a brief summary of the study findings. Following Section VI is a dictionary of marijuana terms used here, as well as a reference list for the interested reader.

Prevailing MIP Production Techniques

This section provides descriptions of marijuana infused product concentrate production techniques used in commercial MIPs in Colorado. The information contained in this section was obtained through a series of interviews conducted between April 24 and June 18, 2015.

The voluntary industry outreach process consisted of 11 in-person interviews, facility tours, and phone interviews with MIP operators and testing facilities. No identifying information of specific facilities is included in this report to protect the privacy and intellectual property of interviewees. The interviews consisted of the following business types organized by primary production process:

- Butane/hydrocarbon concentrates (4);
- Carbon dioxide concentrates (2);
- Butter-based edibles (2);
- Butane/hydrocarbon edibles (2); and
- Carbon dioxide edibles (1).

In addition to the individual interviews, the study team attended two industry group meetings at the request of the Marijuana Industry Group (MIG) and the Cannabis Business Alliance (CBA). The meetings allowed member businesses to ask questions and provide their input to the study in group format.

PRODUCTION TECHNIQUE SUMMARY

Several cannabinoid extraction techniques are used in the production of marijuana concentrates and edibles. The majority involve using a solvent process where solvents are introduced to marijuana plant material to form a concentrate. The solvents are then removed through various refining techniques to produce a refined oil in various consistencies. Potential solvents include hydrocarbons, carbon dioxide, butter/cooking oils/lipids, ether, ethanol, isopropyl alcohol, water, and dry extraction methods. Several extraction methods involving hydrocarbons and carbon dioxide were borrowed from long-standing methods used in the fragrance and food industries.

Over the course of the interviews, it became apparent that while any of the aforementioned solvents can produce a marijuana concentrate or other infused product, commercial producers prefer hydrocarbon, carbon dioxide, and butter/lipid extraction processes. Interviewees cited solvent costs, efficiencies in production,

THC vs. THCa

Marijuana flower is often said to contain THC, but this is not technically true. The plant contains "THCa", which is not psychoactive in its natural state. THC is created through decarboxylation.

Decarboxylation is the process of heating THCa, which naturally occurs in cannabis plants, to activate THC that can be absorbed in the body through ingestion. In the process, the THCa loses carbon and oxygen molecules, and about 12.3 percent of its weight.

This weight reduction is calculated using the molecular weight of THCa and THC.

Although the report authors refer to both THC and THCa throughout the report, the reader can interpret the terms as synonomous.

and output product quality as reasons for using these preferred solvents.

Metrc™ data confirmed that these three solvents account for over 93 percent of edibles production in the state. The interview participants used variations on the three major solvent processes shown above. Each process is described in more detail below.

HYDROCARBON EXTRACTION PROCESS

Hydrocarbon extraction uses any number of hydrocarbons as the principal solvent. Butane and propane are the most common solvents used in commercial operations. When cannabis plant matter comes in contact with the hydrocarbons; cannabinoids, terpenes, and other compounds dissolve into the solvent. The hydrocarbon solvent and cannabinoid mixture is purged using vacuum ovens to remove the solvents.

The purging process leaves only cannabinoids and other desired compounds in a refined concentrate. Hydrocarbon concentrates are often called butane hash oil (BHO), shatter, or wax. All of these products refer to slightly different refining techniques that occur after the BHO is extracted from the plant matter. BHO and other variants contain a high concentration of THCa, often between 60 percent and 95 percent, depending on the amount of refinement and quality of inputs.

If BHO is used to make infused edible products, it must be decarboxylated. Decarboxylation converts the THCa in cannabis plants into psychoactive THC. Decarboxylation requires heating the BHO to 240°F–250°F until bubbling dissipates to achieve desired results. BHO sold for smoking or vaporizing does not require decarboxylation.

Table II-1 shows information on weight yields and THCa potency for hydrocarbon extractions obtained during the industry outreach process. Weight yield is the ratio of output weight to input weight. THCa potency is obtained from metrc™ as part of the mandatory testing for potency and safety. Table II-1 presents THCa for all establishments regardless if the end product is a concentrate or edible.

Table II-1. Butane Extraction Weight Yields and THCa Potency

	Product Type	Primary Input	Input Potency (% THCa)	Weight Yield (%)	Output Potency (% THCa)
MIP 1	BHO Wax/Shatter	Trim	12-20	12-22	60-80
MIP 2	BHO Wax/Shatter	Trim	15-20	10-25	70-95
MIP 3	BHO Wax/Shatter	Trim	10-20	10-20	65-90
MIP 4	BHO (edibles)	Trim	10-17	15-20	65-80

Source: MIP interviews April - June 2015.

CARBON DIOXIDE EXTRACTION PROCESS

Carbon dioxide (CO_2) fluid extraction techniques have been used for various industrial applications in the food and cosmetic industries. CO_2 at very high (supercritical) or low (subcritical) pressures is used to extract cannabinoids from plant material. Different combinations of temperature and pressure are used in the extraction. CO_2 is a popular solvent due to its lack of toxicity and its perception as a less dangerous form of cannabis concentrate. CO_2 oils are a popular ingredient in vaporizing concentrates for use with a stationary vaporizer or a portable vaporizer pen.

CO_2 fractionations[2] at different pressures in the production process can yield different product consistencies and compositions. Plant waxes remain in varying amounts in the raw extraction, which is often refined further using various techniques involving an ethanol wash or refrigeration techniques called winterization.

2 Fractionation is a separation process in which a certain quantity of a mixture (gas, solid, liquid, suspension or isotope) into a number of smaller quantities (fractions) in which the composition varies according to a pressure or temperature gradient.

The refining process removes plant waxes, chlorophyll, or other undesirable elements.

Similar to BHO, CO_2 oil contains THCa concentrations between 60 percent and 85 percent, depending on the amount of refinement and quality of inputs.

CO_2 extractions must be decarboxylated to make edible products. An increasing number of edible products are made with decarboxylated CO_2 oil as the active ingredient. The decarboxylation process with CO_2 oil is similar to BHO.

Table II-2 shows weight yields and THCa potency for CO_2 extractions obtained during the industry outreach process. Table II-2 presents THCa for all establishments regardless if the end product is a concentrate or edible.

BUTTER AND COOKING OILS

Perhaps the most widely known method for extracting cannabis for edible preparations involves the use of butter, coconut oil, and other cooking oils. Cannabinoids are fat soluble, and MIPs add cannabis to butter and other oils and the mixture is heated to 240°F–250°F.

Table II-2. CO_2 Extraction Weight Yields and THCa Potency

	Product Type	Primary Input	Input Potency (% THCa)	Weight Yield (%)	Output Potency (% THCa)
MIP 1	CO_2 Oil	Trim	12-17	10-15	80-85
MIP 2	CO_2 Oil	Trim	15-17	8-12	70-80
MIP 3	CO_2 Oil (edibles)	Trim	10-15	8-10	60-65

Source: MIP interviews April - June 2015.

Some MIPS vary this process by decarboxylating the plant material before adding it to the butter. Then plant material is strained and the butter is brought back to room temperature.

MIPs are required to test each batch of cannabis butter or oil for potency. After a batch of butter is made and tested for potency, the MIP may add additional butter or oil if necessary to adjust the potency in accordance to its recipe. Then the cannabis butter or oil is measured in the recipe to determine the appropriate potency for each batch of baked edible products. The butter MIP operators indicated that they have formed relationships with wholesale suppliers for trim, and they generally know the potency range of their raw cannabis butter, but natural variation exists in each package of plant material used to produce butter-based edibles.

Table II-3 shows weight yields and THC potency for butter and oil extractions obtained during the industry outreach process.

OTHER SOLVENTS

Marijuana concentrates and infused products can also be manufactured using a host of other solvents, including isopropyl alcohol, ethanol, vegetable glycerin, water, and dry/solventless (kief).

While these methods are employed in Colorado for some commercial production, no MIPs in the interview group reported use of these methods on a commercial scale. These extraction methods are in use for small production batches and represent less than 7 percent of the market.[3] The interviewees often referred to these products as a "cottage" or "artisanal" market.

In the following section, metrc™ data is used to provide production equivalency calculations for alcohol and water based extraction methods in addition to the methods encountered in the interviews (hydrocarbon, CO_2, and butter/oil).

3 Based upon author calculations from metrc™ data.

Table II-3. Butter and Oil Extraction Weight Yields and THCa Potency

	Product Type	Primary Input	Input Potency (% THCa)	Weight Yield (%)	Output Potency (% THC)
MIP 1	Butter edibles	Trim	10-15	3-4	1.9-2.5
MIP 2	Butter edibles	Trim	15-22	2.75-3.25	2.0-2.8

Source: MIP interviews April - June 2015.

Physical Equivalency Calculations

In this section, metrc™ data is used to identify statewide average conversions of marijuana plant inputs into marijuana product outputs. Together with the MIP production structure defined above, these two sections combine to produce conversion rates between plant-based inputs and infused or concentrated outputs.

The study team developed two types of physical equivalency calculations: a simple THC conversion and a more nuanced physical conversion. The physical conversion traces the marijuana through the concentrate and edible production process and matches inputs (marijuana plant material) with outputs (concentrates and infused products). The THC conversion presents a more basic equivalency that quantifies equal amounts of THC in marijuana concentrates, edibles, and plant material. The equivalencies are organized by the major solvents used in production.

Inventory tracking data is used to trace the path between cultivation centers, marijuana infused products (MIP) manufacturers, and final retail centers. Disparate data sources needed to be translated and combined in order to complete this task. For example, marijuana packaging data provides information about product contents and source, facility information is used to categorize package owners and transfers. Transfer manifests provide an accounting of shipments of intermediate and final products between facilities, and testing results are used to establish potency among product types.

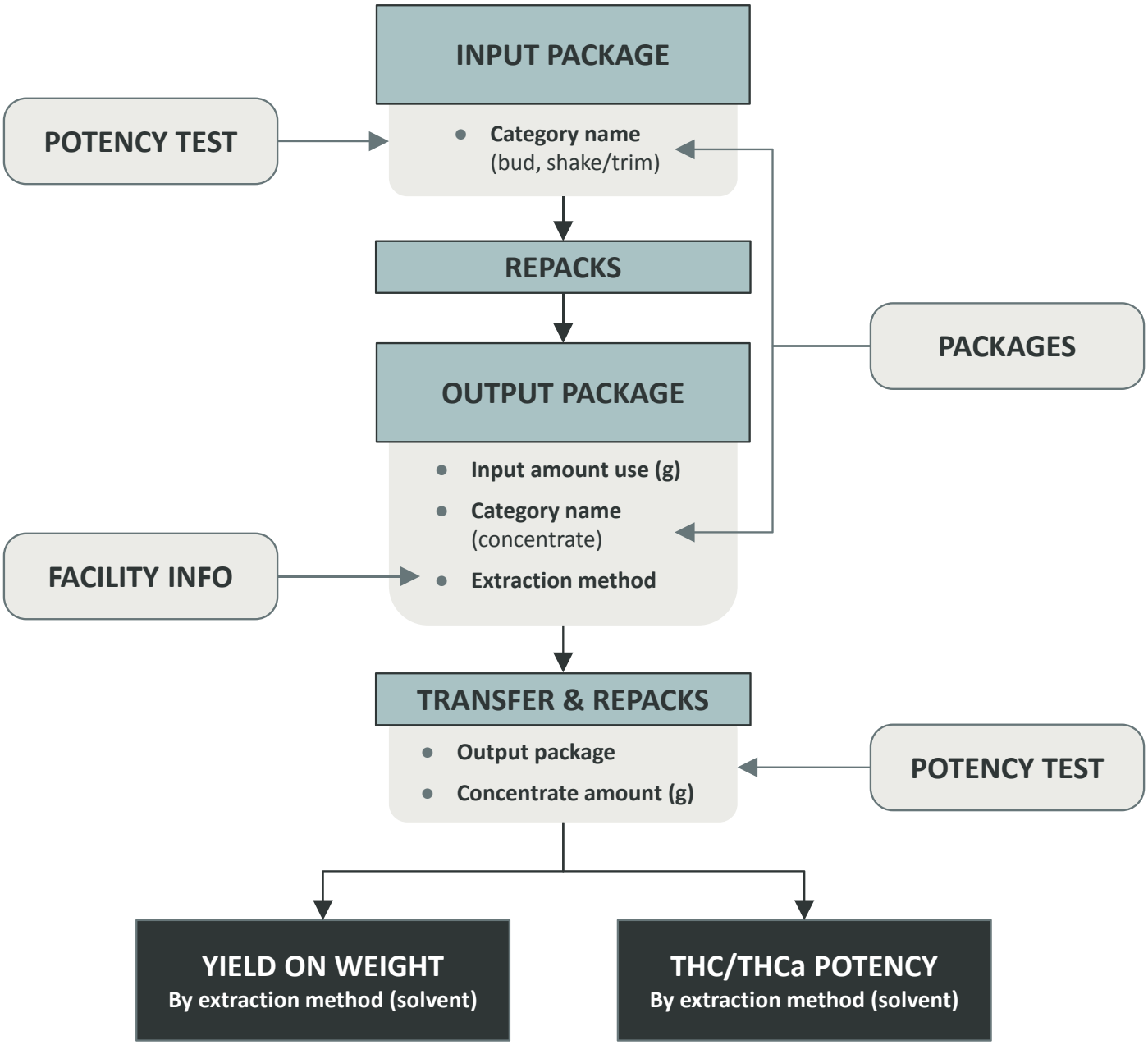
After plants are harvested and cured, marijuana flower and trim are registered as “packages.” The packages are transferred to retail stores for sale or to MIPs for further processing. Package records contain identifying information about package contents and the facilities on either end of a package transfer.

The study team built a genealogy of packages that traces them through the production process and correlates input packages of trim and flower to output packages of marijuana concentrates and infused products at MIP facilities.

Once an input and output package is linked, the study team mines the state inventory data to obtain identifying information about the production process and package contents. Equivalency calculations are provided for extraction processes that use butter and cooking oils, butane/hydrocarbons, CO2, water, and alcohol/ethanol as primary solvent. The calculations provide information on the yield on weight and input/output THC amounts for each production process.

For example, in butane hash oil (BHO) manufacturing, if a production batch starts with 1,000 grams of trim and yields 180 grams of BHO, then we calculate a weight yield of 18 percent. The study team then queries the testing database to obtain THCa and THC figures for trim, flower, concentrates, and edibles to obtain potency information for production inputs and outputs. The process diagram in Figure III-1 shows the data collection process in metrc™ for weight yield and potency.

Figure III-1. Physical Equivalency Calculation Process



The calculation process provides the weight yield and potency figures in Table III-2. Table III-2 provides the mean weight yield, 95 percent confidence interval range and sample size for each solvent type included in the analysis. Table III-2 also provides information on potency testing for each solvent type. Marijuana flower and shake/trim potency is also included.[4]

The figures in Table III-2 show between 9.7 and 17.1 percent concentrate weight yield rates on non-butter solvents with relatively narrow confidence intervals.

Using butane as an example, a 1,000-gram production batch of trim yields on average 171 grams of BHO with a mean potency of 71.7 percent THCa. These calculations have a sample size of over 11,500 for weight yield and over 5,600 for potency.

4 Testing results display combined THCa and THC for each solvent type. Butter and oil potency is listed as amounts of THC due to decarboxylation. All other solvent types contain almost exclusively THCa.

Table III-2. Marijuana Concentrate Yield and Potency

	Yield Calculations				Potency Calculations					
Solvent	Mean Weight Yield	95% Lower Bound Weight Yield	95% Upper Bound Weight Yield	(n)	Mean THC/ THCa %	95% Lower Bound % THC/ THCa	95% Upper Bound % THC/ THCa	(n)	Bud %	Shake/ Trim %
Butane	17.11%	16.76%	17.46%	11,514	71.67%	71.20%	72.14%	5,606	11.43%	88.57%
CO_2	15.18%	14.80%	15.55%	7,257	61.39%	60.27%	62.51%	1,950	3.51%	96.49%
Butter	504.50%	484.69%	524.32%	599	2.57%	2.04%	3.09%	216	9.72%	90.28%
Water	9.72%	9.01%	10.43%	1,270	58.30%	56.34%	60.26%	266	9.91%	90.09%
Alcohol/ Ethanol	17.06%	14.37%	19.76%	241	67.17%	64.08%	70.25%	201	16.46%	83.54%
Flower					17.47%	17.41%	17.53%	26,023		
Shake/Trim					15.53%	15.26%	15.80%	1,591		

Source: Author calculations based on metrc™ data.

The butter "yield" rate differs from other solvents because it is a different production process. The butter yield results can be interpreted as the weight of cannabis butter produced per weight of plant input. For example, 100 grams of cannabis in a production batch would yield on average 502 grams of cannabis butter at a mean THC of 2.57 percent or 25 mg of THC per gram of butter.)[5]

The yield and potency figures described above are inputs to the physical equivalency calculations. For concentrates sold or transferred directly to retail stores, the figures in Table III-2 provide the information for an equivalency. For marijuana edibles, these figures are supplemented by several intermediate calculations shown in Table III-3.

All figures from Table III-2 are converted from percentages into milligrams per gram, as shown in Table III-3. This conversion is necessary because edibles in the adult use retail market are sold in two standard sizes (10mg and 100mg)[6] based on the amount of THC contained in the edible product.

The calculations in Table III-3 show the average potency of each solvent used in edibles production, the amount of solvent necessary to produce an edible product with 10mg of THC, and the amount of marijuana plant material necessary to produce 10mg edible product. On average, between .08 and .09 grams (or 80–90 mg) of plant material is required to make an edible product containing 10mg of THC.

Table III-4 shows equivalency calculations based on the physical approach described in Table III-3. Equivalencies are organized by solvent type and shown for edibles and concentrates. The process estimates the amount of plant material used in each 10 mg and 100 mg edible package and provides a calculation of the amount of edible packages that can be produced from an ounce of dried marijuana flower.

For concentrates available directly for sale, the study team provides estimates of the amount of plant material used to make one gram of concentrate at average potency for each solvent type. Similar conversions for an ounce and a quarter-ounce of marijuana flower are provided.

Table III-4 provides estimates of the amount of trim used in each production process and then converts trim amounts to flower equivalents using a THC-based conversion factor derived from the testing data presented in Table III-2.[7]

5 The butter yield rate was the most difficult to interpret because of the many weight units that can be used to describe the prepared cannabis butters. There is also the possibility that some manufacturers report the output units after additional non-psychoactive butter is added to the cannabis butter. The 5-to-1 yield ratio is somewhat higher than what was discussed in our interviews. The authors have elected to use the metrc™ data due to the amount of data (1,623 records) that support the figures in Table III-2.

6 Two dosages are outlined in state statute. One is 10mg., which represents a standard dose of THC. The second is 100 mg., which contains 10 servings and represents the maximum amount of THC allowed in an edible retail marijuana infused product.

7 Trim has on average 15.53 percent THC and flower has on average 17.47 percent THC; therefore, a conversion ratio is calculated at 1.125.

Table III-3. Edibles Intermediate Calculations

Solvent	mg THC/g Solvent	g Solvent per 10 mg Edible	g Trim per 10 mg Edible
Butter	25.70	0.39	0.08
Butane	716.70	0.014	0.08
CO_2	613.90	0.016	0.09

Source: Author calculations based on metrc™ data.

Table III-4. Physical Equivalency Calculations

Product Type	Solvent	Purchase Amount	Trim Used in Production	Flower Equivalency Ratio	Ounce Equivalent	Quarter-Oz Equivalent
Edible	Butter	10 mg	0.08 g	0.07 g	413.49 each	103.37 each
Edible	Butter	100 mg	0.77 g	0.69 g	41.35 each	10.34 each
Edible	Butane	10 mg	0.08 g	0.07 g	391.07 each	97.77 each
Edible	Butane	100 mg	0.82 g	0.72 g	39.11 each	9.78 each
Edible	CO_2	10 mg	0.09 g	0.08 g	346.96 each	86.74 each
Edible	CO_2	100 mg	0.92 g	0.82 g	34.70 each	8.67 each
Concentrate	Butane	1 g	5.84 g	5.20 g	5.46 g	1.36 g
Concentrate	CO_2	1 g	6.59 g	5.86 g	4.84 g	1.21 g
Concentrate	Ethanol	1 g	5.86 g	5.21 g	5.44 g	1.36 g
Concentrate	Water	1 g	10.29 g	9.15 g	3.10 g	0.77 g

Source: Author calculations based on metrc™ data.

The physical equivalencies in Table III-4 show that about between 347 and 413 edibles of 10 mg strength can be produced from an ounce of marijuana, depending on the solvent type and production method. For concentrates, between 3.10 and 5.50 grams of concentrate are equivalent to an ounce of flower marijuana.

The conversion factors described above can be useful for state-level production management. The conversions allow units of infused edibles and concentrates to be expressed in equivalent flower weight, and then added to flower sales, in order to determine retail market demand and supply.

ALTERNATE METHODOLOGY

A second, simpler methodology is presented in Table III-5 that employs THC as the common unit for conversion between the various forms of marijuana products. This methodology calculates an equivalent amount of THC in various forms of marijuana products based on the testing information shown in Table III-2.

The equivalency factors in Table III-5 can be interpreted as showing units with equivalent amounts of THC. For instance, given the uniform dosage amounts of edibles

in Colorado, all 10mg strength edibles have an amount of THC equivalent to 60 mg (0.06 g) of flower marijuana at the average potency. A conversion rate of 1.14 is applied to convert THC in infused products back to THCa in flower due to weight loss in the decarboxylation process involved in manufacturing edibles.[8]

8 Decarboxylation is the process of heating THCa, which naturally occurs in cannabis plants, to activate THC that can be absorbed in the body through ingestion. In the process, the THCa loses a carbon dioxide molecule and about 12.3 percent of its weight. Conversion calculation from THC back to THCa uses 1/(1-.123) or 1.14. This weight reduction is calculated using the molecular weight of THCa and THC obtained from Steep Hill Labs http://steephilllab.com/resources/cannabinoid-and-terpenoid-reference-guide/.

For retail concentrates equivalency calculations, the THC/THCa conversion is not necessary because concentrates are not decarboxylated for direct retail sale. The THC in one gram of concentrate is equivalent to between 3.05g and 3.75g of marijuana flower at average potency. Ounce and quarter-ounce equivalents are also provided in Table III-5.

Table III-5. Simple THC Equivalency Calculations

Product Type	Solvent	Purchase Amount	THC Amount	THCa Amount	Flower Equivalency Ratio	Ounce Equivalent	Quarter-Oz Equivalents
Edible	Butter	10 mg	10 mg	11.40 mg	0.07 g	434.35 each	108.59 each
Edible	Butter	100 mg	100 mg	114.03 mg	0.65 g	43.43 each	10.86 each
Edible	Butane	10 mg	10 mg	11.40 mg	0.07 g	434.35 each	108.59 each
Edible	Butane	100 mg	100 mg	114.03 mg	0.65 g	43.43 each	10.86 each
Edible	CO_2	10 mg	10 mg	11.40 mg	0.07 g	434.35 each	108.59 each
Edible	CO_2	100 mg	100 mg	114.03 mg	0.65 g	43.43 each	10.86 each
Concentrate	Butane	1 g	0.72 g	0.72 g	4.10 g	6.91 g	1.73 g
Concentrate	CO_2	1 g	0.61 g	0.61 g	3.51 g	8.07 g	2.02 g
Concentrate	Ethanol	1 g	0.67 g	0.67 g	3.84 g	7.37 g	1.84 g
Concentrate	Water	1 g	0.58 g	0.58 g	3.34 g	8.50 g	2.12 g

Source: Author calculations based on metrc™ data.

Pharmacological Equivalencies

An important compliment to the physical THC relationships identified in this study is the pharmacological perspective. If the purpose of the equivalency legislation is to limit transactions or possession to a reasonable "dose" of concentrates and marijuana products for residents and non-residents, then the medical effects described here will be useful to construct a set of equivalencies between marijuana products.

There are several methods to consume marijuana such as intravenous, oral mucosal, ingested, transdermal, and inhaled. The two most popular methods for consumption are ingestion and inhalation. We focus upon these two methods in this study. The remaining methods are either reviewed briefly or are provided as references for the interested reader.

The reader should understand that this section does not represent a clinical study. Instead, this section uses findings from other studies to inform marijuana stakeholders about the dosing process, and it provides a new mathematical construct that can compare ingested and smoked marijuana products in a consistent manner. Therefore, this report should be considered to be a policy-driven study that leverages medical literature to provide scientific evidence during the construction of dose equivalencies between various marijuana products.

This section focuses upon the psychoactive components of marijuana, primarily THC and related chemicals, and does not focus upon the medicinal effects of marijuana because the findings and resulting regulations will be applied only to Colorado's retail marijuana market, under House Bill 14-1361.

ENUMERATION OF THC UPTAKE METHODS FOR MARIJUANA

The psychoactive component of marijuana, THC (and THC derivatives) can be delivered to the recipient in a number of ways. Each method translates into a different net amount of THC entering the bloodstream and the brain.

- **Flower smoking:** Over the past 30 years, smoking has been the most common method to consume marijuana. Based upon 2014-15 data, the THC content in Colorado retail flower lies between 8-22 percent, with a mean estimate of roughly 17 percent. Therefore, one gram of marijuana flower contains 170 milligrams of THC, on average. However, a large portion of that THC is destroyed during the smoking process. In this report, we itemize the uptake rates and the potential loss of THC through smoking, during the process of inhalation, exhaling, and blood-clearance. The process is further complicated by the transfer process of THC from the blood plasma, into the brain itself.

- **THC ingestion:** Alternatively, THC can be infused into edible products such as baked goods or candies, and then eaten. By state law, each serving of edibles is limited to no more than 10 milligrams of THC content. THC, when ingested, will be absorbed at different levels, depending upon other foods in the stomach, and upon the chemical nature of the pre-existing foods. As with smoked products, a majority of the THC is not absorbed by digestion. Various studies, which will be discussed below, suggest that between 6-20 percent of the THC content in an edible product is metabolized and absorbed into the bloodstream. However, ingestion and processing by the liver has been found to create an important THC byproduct that subsequently boosts the psychoactive effect of THC. This research will be discussed later in this section.

- **Concentrate smoking or "dabbing:"** This method also uses smoking as the uptake method, but the material contains very high concentrations of THCa.

The typical THC content in concentrated forms of marijuana varies between 60-80 percent, although rates as high as 95 percent have sometimes been observed. By heating and smoking these concentrates, the uptake ratios are similar to smoking marijuana flower, but the ratios of THC to flower-based cannabinoids may be different, creating a different type of psychoactive effect.

THC, THCA, 11-OH-THC AND THC-COOH[9]

The underlying chemistry for marijuana, and its psychoactive elements is complex and beyond the policy scope of this report. A large number of clinical studies and medical findings are cited later in this section. This subsection provides a brief and concise overview of the main psychoactive component in marijuana, THC. In addition to THC, there are cannabinoids, typically labeled using a root form, CBD, and then enumerated, such as "CBD-A" or "CBD-B." Many cannabinoids contain psychoactive elements as well, but the type of effect caused by those cannabinoids is not typically as strong as THC.

Because this study is designed for the retail market, and not the medical market, only the psychoactive THC and THC related chemicals are considered.

The reader is reminded that marijuana flower (or buds) does not contain THC itself, but instead contains THCa (Tetrahydrocannabinolic Acid), a precursor to THC. The relationship between THCa and THC is explained at the beginning of this report.

THC itself is the primary psychoactive component in marijuana, but there are also related chemicals that have been found to have an amplification effect upon the base blood levels of THC. In particular, when THC is ingested, it is then oxidized and converted by the liver into the active metabolite named 11-hydroxy-THC (11-OH-THC) [see 23, 25], and 11-nor-9-Carboxy-THC (THC-COOH), a secondary, non-psychoactive metabolite.[10] Recent studies have found that 11-OH-THC penetrates the brain barrier more quickly than regular THC, causing a markedly-higher psychoactive effect. We cite a number of studies below, to estimate the relative potency of 11-OH-THC versus regular THC in blood levels, in order to more accurately characterize the psychoactive effects between ingestion and inhalation of THC.

IDENTIFICATION OF THC UPTAKE AND BENCHMARKING

This section describes THC uptake, delivery methods, and related dosing. The dosing relationships between uptake methods (smoking and ingesting) can be quite different from the physical weight relationships that were identified in the first half of this report. One relationship is pharmacokinetic, while the other is purely physical.

Comparing Peak Effect vs. Aggregate Effect

It is also important to recognize the differences between "peak effects" or "aggregate effects." The former measure identifies the most intense moment experienced by a subject during a dosage event with marijuana. This can

9 Please note that this sub-section is an overview of report findings. In order to be concise, only a few of the specific technical references and citations are provided here. Instead, most citations are provided, combined, and enumerated during the longer, technical exposition at the bottom of this section.

10 THC-COOH is a non-psychoactive metabolite formed in the liver when THC is ingested or smoked. Due to its inactive nature, it is not factored into equivalency calculations See source 9 in references section.

be characterized as the "peak intensity" of the high. The latter measure calculates the integral, or area under the curve where the curve relates to blood-levels of THC and 11-OH-THC over time.

Typically, smoking produces a higher peak effect, as THC enters the blood stream through lung tissue. But THC levels are also quickly reduced when smoked, as the body works to clean contaminants from the bloodstream. Conversely, edible products absorb much more slowly, so that the effect is delayed compared to smoking. However, the digestion and oxidization process last much longer.

For example, Figure IV-1 shows the THC and related chemicals in the blood stream over time. As shown, THC concentrations peaked 90 minutes after ingestion, and 11-OH-THC peaked slightly later, at approximately 110 minutes. Levels of these psychoactives remained elevated for approximately 300 minutes, or five hours, and non-active THC-COOH remained elevated for 1,400 minutes (almost 24 hours).

In contrast, smoking concentrations were much higher, and shorter. Figure IV-2, taken from the "California NORML Guide Interpreting Drug Test Results,"[11] combines results from smoking and ingested THC to reveal the relative magnitude of blood plasma levels.

11 Sourced from: http://www.canorml.org/healthfacts/drugtestguide/drugtestdetection.html#fn03. Last visited on June 13, 2015.

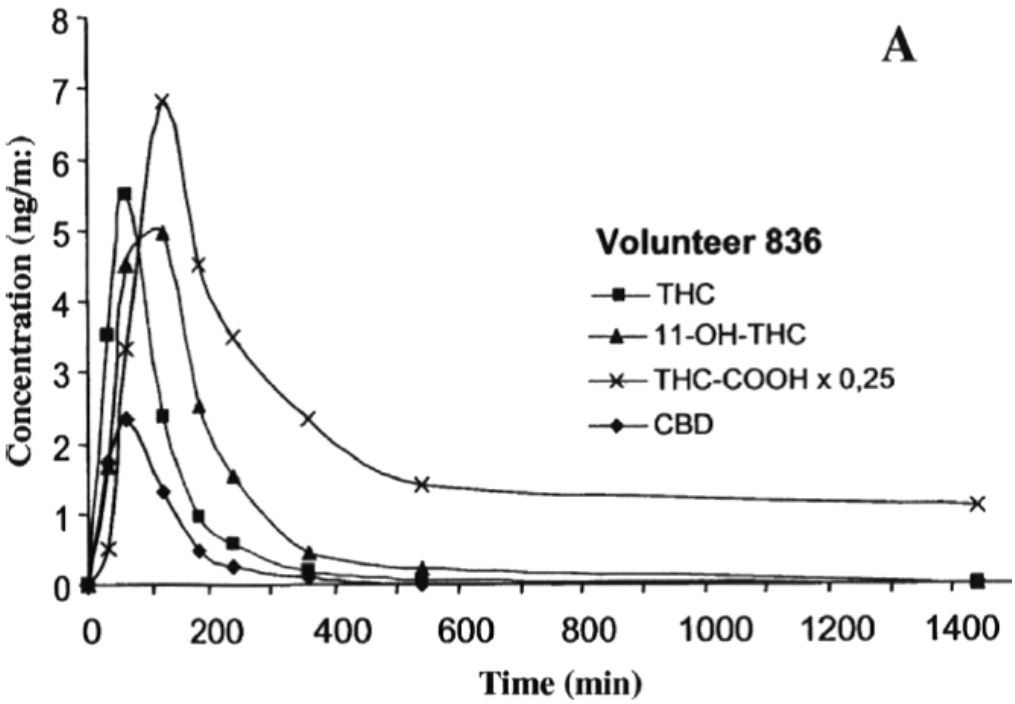
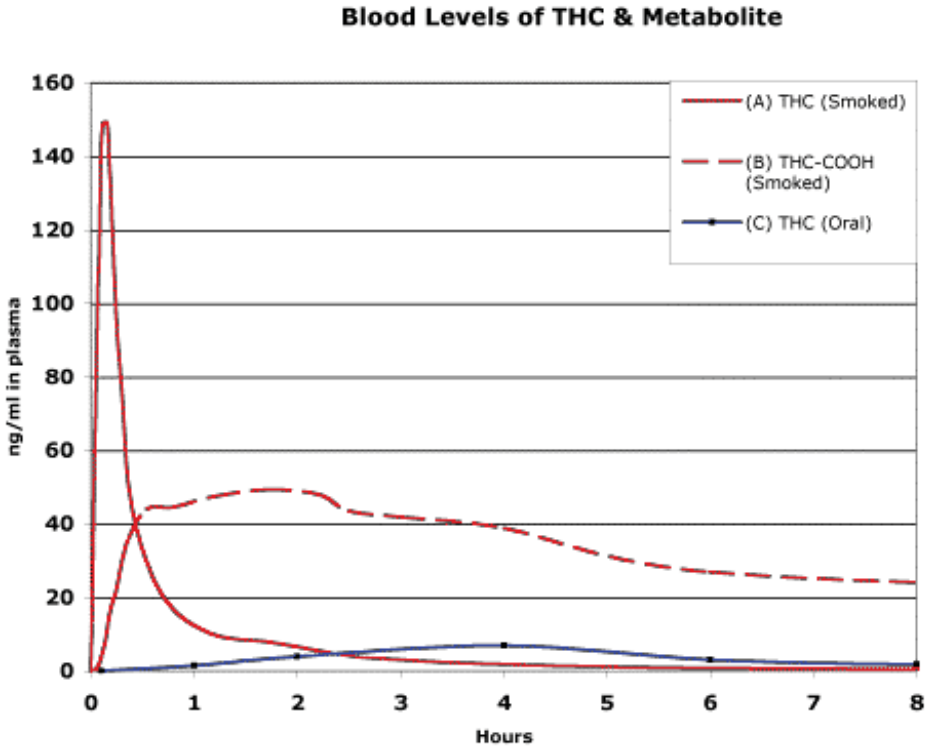


Figure IV-1. An Example of Blood Plasma Concentration Rates of THC Derivatives Over Time, After Oral Ingestion of Marijuana Products. From Nadulski et. Al. (2005).

Figure IV-2. Comparison of Inhaled Versus Ingested THC Elements



References:

(A-B) Smoked dose based on data from M. Huestis , J. Henningfield and E. Cone,M. Huestis , J. Henningfield and E. Cone. [08] M. Huestis , J. Henningfield and E. Cone,"Blood Cannabinoids. I. Absorption of THC and Formation of 11-OH-THC and THCCOOH During and After Smoking Marijuana", Journal of Analytic Toxicology, Vol. 16: 276-282 (1992).

(C) Oral dose based on data from B. Law et al. ([03] B. Law et al, "Forensic aspects of the metabolism and excretion of cannabinoids following oral ingestion of cannabis resin," J. Pharm. Pharmacol. 36: 289-94 (1984).)

Figure IV-2 shows that THC plasma concentrations are more than 10 times higher for smoked cannabis compared to ingested cannabis. The more recent findings from Nadulski, et. Al. (2005) suggest that while THC and 11-OH-THC levels peak much earlier than suggested by Law, et al. (1984), the relative magnitudes are similar. Peak levels were 5-6 ng/mL in the Nadulski study, and approximately 8 ng/mL in the Law study.

These findings suggest that either smoked marijuana experiences are significantly more intense, or—as scientists suggest—that 11-OH-THC produces an extenuated effect, compared to base THC. It also suggests that the relationship between blood-plasma THC levels do not necessarily correspond to psychoactive effects in a strictly-linear fashion.

Indeed, for the psychoactive effects to occur, the THC must penetrate the blood-brain barrier and connect directly to the brain. This means that even though blood-plasma THC levels are 10 times higher when smoking versus ingesting THC, the psychoactive effect may not be 10 times as intense, because THC is not necessarily reaching the brain at the same rate as it flows in the blood plasma.

As discussed earlier, 11-OH-THC has an extenuating effect. According to Perez-Reyes, et. al. [26], it has been found to penetrate the brain membrane approximately four times faster than THC. This suggests 11-OH-THC will contribute more rapidly to the psychoactive effects than THC. Also, by elongating the amount of time that THC is elevated in the blood plasma when THC is ingested and processed by the liver, there is more time for the THC

to penetrate the brain membrane and therefore a higher ratio of absorption of THC and other psychoactives into the brain fluid.

Together, this suggests that lower concentrations of THC in blood plasma do not necessarily imply that consumers are experiencing a lower intensity of psychoactivity. Instead, the level of THC and 11-OH-THC, combined with the time these metabolites have to penetrate the blood brain barrier, will determine the comparative psychoactive effects between inhaling and ingesting marijuana products.

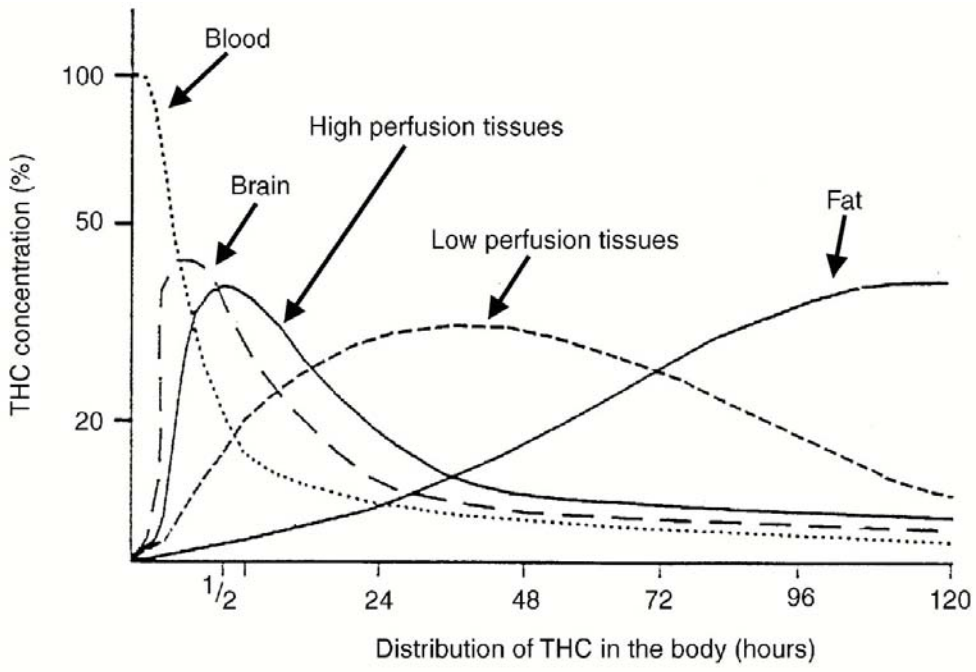
The different rates of tissue absorption are shown more clearly in Figure IV-3. Here, blood plasma levels are the immediate recipients of THC, yielding high rates of THC concentration. However, rate of brain absorption from the blood is slower, as discussed earlier. Next, the so-called "High perfusion" tissues begin absorbing THC, followed by "Low perfusion" tissues, and finally, fat tissues.

ROLE OF THE BLOOD-BRAIN-BARRIER (BBB)

A barrier, or sheath, separates the brain from the human body blood stream. There are several descriptions of the BBB.[12] In general, the BBB is a highly selective permeable

12 See, for example: Blood-Brain Barrier: Drug Delivery and Brain Pathology, edited by David Kobiler, Shlomo Lustig, Shlomo Shapira, 2012. Springer Science & Business Media, Dec 6, 2012. A clear description for the lay person can also be found on Wikipedia: https://en.wikipedia.org/wiki/Blood%E2%80%93brain_barrier. Accessed on June 16, 2015.

Figure IV-3. Distribution of THC in the Body. Blood and Brain Absorption Rates Differ Significantly.



References:

Nahas, G. G. (1975) Marijuana: toxicity and tolerance. In Medical Aspects of Drug Abuse (ed. R. W. Richter), pp. 16-36. Baltimore, MD: Harper & Row.

barrier that separates the circulating (pulmonary) blood from the brain extracellular fluid that circulates in the central nervous system. The blood–brain barrier is formed by brain endothelial cells, which are connected by tight junctions with a high electrical resistivity. The BBB allows water and some gases to pass through, as well as lipid-soluble molecules. It also allows the selective transport of molecules, such as glucose and amino acids that are crucial to neural functioning. The BBB will often prevent the entry of lipophilic, potential neurotoxins by way of the so-called active transport mechanism. A small number of regions in the brain do not have a blood–brain barrier.

The BBB is an important factor that limits the flow of THC between the body's blood plasma and the brain, where it creates the psychoactive effects. Where THC is allowed to penetrate the BBB, the rate of penetration is slow. In contrast, scientists have found that the rate of penetration for 11-OH-THC is much faster.

The selective permeability of the BBB causes a competition. On the one hand is the BBB/THC passage rate allowed by the BBB, and on the other hand is the metabolic clearance rate for toxins in blood-plasma. The BBB slowly allows THC to pass through the membrane, causing the psychoactive effects. But at the same time, the body's metabolism will purify the blood stream, rapidly removing the THC from blood-plasma.

This competition causes a decrease in THC effectiveness from inhalation, compared to the slower, steadier THC supply from ingestion. As shown in Figure IV-2, the concentration of THC in the blood stream is much higher when inhaled than when ingested. But due to blood plasma clearance, the ratio quickly falls to relatively low levels (e.g., in 30 minutes).

The limitations incurred by the BBB suggest that much of the THC in the blood-plasma is therefore lost, because the BBB slows conversion of blood-plasma THC into "effective" THC within the brain itself. The share of THC that actually passes through the BBB and into the brain during the short period when blood-plasma levels are high is estimated to be approximately 35 percent. Just over one-third of the THC in the blood plasma is captured by the brain before it is cleaned out by the body's pulmonary system.

CONSTRUCTING DOSING EQUIVALENCIES FOR MARIJUANA PRODUCTS

This is the first time that data from an official marijuana market is combined with medical research to develop scientifically-based relationships between marijuana products. The estimates reflect the best-available data and knowledge as of the report publication. Over time, we hope that further research can be used to improve upon the methods here, and to refine the estimates as knowledge of the subject matter continues to improve.

In order to synthesize the various pharmacokinetics of marijuana uptake into a simple, actionable metric, we suggest using a THC conversion factor. The conversion factor for purposes of dosing will compare the amount of weight-based THC contained in smokable products, such as marijuana flower and concentrates, with the amount of weight-based THC contained in ingested THC products such as edibles.

For example, if the THC conversion factor for dosing equals 1:5, this means that one milligram of THC in edible form (ingested) is roughly equal, from a dosing perspective, to 5 milligrams of THC in a smokable form. This section will provide a basic conversion factor model that synthesizes the scientific findings discussed earlier, in order to construct the THC conversion model.

The THC conversion factor is based upon a combination of findings. Among them are: the typical THC loss rate during the smoking process; the typical loss rate of THC for ingested products; the absorption rate of THC vs. 11-OH-THC in the brain; and the estimated comparative psychoactive intensity of THC versus 11-OH-THC.

For clarity, the uptake relationship can be parameterized and displayed mathematically. The following equations explain the relationship between each pharmacokinetic finding and the overall impact of that finding upon the equivalency factor between inhaled and ingested products.

First, the effective uptake of THC or THC derivatives from inhalation can be simplified using the following formula:

$$U^I = (cw)\alpha_{IN}\alpha_{EX}\beta$$

The total uptake U, is the product of the flower weight, w, times the THC/THCa content. This yields the THC weight available for inhaling. This amount is then scaled by the share of THC captured during the inhalation, α_{IN}, and also by the share of THC retained in the lungs after exhalation, α_{EX}. These inputs determine the level of THC that will ultimately be absorbed into the subject's blood plasma. Finally, the share of THC that passes through the BBB from the blood-plasma is denoted by β. The product of these parameters reveals the effective THC uptake from inhalation of activated THC.

The uptake ratio for the THC content alone can be obtained by simply dividing by the marijuana flower weight and THC concentration (cw). After doing this, we denote u^I to be the uptake conversion factor. It is:

$$u^I = \frac{U^I}{(cw)}$$

For edibles, a similar approach can be used. Edibles come in various shapes and sizes, but are required to contain 10 milligrams or less of THC per serving. This allows for a direct uptake comparison of THC content into effective THC uptake from ingestion.

In edibles, the metabolism of THC into 11-OH-THC is an important consideration. It is also important to acknowledge that the slow, steady release of THC and 11-OH-THC into the blood stream allows most, if not all, of the THC derivatives to pass through the BBB. Thus, the equation below implicitly assumes a blood-brain THC retention share of 100 percent for edible marijuana.

$$U^E = \theta\omega\,(1+\gamma)$$

The total uptake equivalent, U^E, is a function of the THC absorption rate in the stomach, θ, and amount of THC in the product, by weight, ω. Next, the absorbed portion of THC is metabolized into two components, THC and 11-OH-THC, where THC enters the blood stream linearly, but 11-OH-THC, which can pass the BBB more rapidly, receives a conversion factor, γ.

As with inhaled THC, the share ratio of THC uptake can be constructed simply by dividing by the weight of the THC content in the product:

$$u^E = \frac{U^E}{\omega}$$

Finally, a simple equivalency ratio can be derived from the share-value uptake ratios. This equivalency ratio, R, is used to denote the relative psychoactive effect that is embodied in edible versus smokable marijuana products.

$$R = {u^E}/{u^I}$$

Symbol Table

Symbol	Description	Relevant Literature
U, u	Uptake equivalent amount of THC, in weight terms, and unit-free terms, for edibles (E), and for inhalation (I).	Calculated as a function of parameterized values from this report.
C	THC concentration rate in marijuana flower.	Based upon testing observations from Colorado retailers and dispensaries.
W	Weight of marijuana flower.	
α_{IN}, α_{EX}	Share of captured THC during marijuana smoke inhalation, and after exhalation, respectively.	Scientific laboratory studies of marijuana smoking. See See [20], [30], [31].
β	Brain fluid retention rate from blood plasma.	
θ	Absorption rate of THC when ingested in the form of an edible product.	[25], [24], [21], [19], and [13] are studies on oral consumption of marijuana, and its effects upon the human body.
ω	Weight of THC in edible form, in milligrams.	
y	Effective impact of 11-OH-THC that is metabolized by the liver.	Pharmacokinetic studies by [5], [1], [2], [21], and [26].
R	Equivalency ratio – the equivalent dose impact of 1 milligram of THC in edible form, in milligrams of THC in smokable form.	Calculated as a function of parameterized values from this report.

For the purposes of this study, R is the key ratio that can be used to compare edible products with smokable products, from a policy standpoint.

IDENTIFICATION OF PARAMETER VALUES

Each of the parameters in these equations has been studied to some degree. Some studies are directly relevant to specific parameter values, while others are only tangentially relevant, since they were each written for different purposes than this equivalency study. Relevant studies are cited numerically and are included in the references section. For these reasons, this study utilizes a range of values that is based on existing research. This range of values is used to determine a point estimate for the equivalency ratio (R), which is the equivalent dose impact of 1 milligram of THC in edible form, in milligrams of THC in smokable form.

Studies related to α_{IN} and α_{EX}

The physical uptake of THC through smoking has been

discussed as part of various marijuana smoking experiments. Numerous studies examine the absorption of THC through smoking cannabis. The results of these studies vary, with one study putting the range of absorption from 2 percent - 56 percent. A study by Perez-Reyes found that absorption varied widely due to various factors, including marijuana potency, the amount of unchanged THC available in the smoke inhaled, amount of THC lost in side-stream smoke, method of smoking (i.e., cigarette or pipe) and the amount of THC passed through the upper respiratory tract. [12] A thorough examination of these studies leads to a more reasonable range of absorption through smoking of 10-25 percent. [5, 2, 10, 8, 7] This value range will be used in this study for calculations related to smoking equivalencies.

Below are relevant excerpts from the medical literature, related to the uptake ratios of inhalation and exhalation for THC absorption:

[12] *"The factor of absorption from smoking varies in terms of THC uptake and the actual amount of THC that is absorbed through smoking of marijuana. The factors that affect uptake ratios of smoking include, (1) the potency of the marijuana smoked; (2) the amount of unchanged THC present in the smoke inhaled (i.e., the amount of THC not destroyed by pyrolysis); (3) the amount of THC lost in side-stream smoke; (4) the method of smoking (cigarette vs. pipe smoking); and (5) the amount of THC trapped in the mucosa of the upper respiratory tract. These identified factors have made exact uptake ratios of THC difficult to determine, and therefore studies to this point have produced a range of THC absorption."*

[2] *"Past studies indicate that smoking cannabis turns approximately 50% of the THC content into smoke, with the remainder lost by heat or from smoke that is not inhaled. Up to 50% of inhaled smoke is exhaled again, and some of the remaining smoke undergoes localized metabolism in the lung. The end result is that the estimated bioavailability of a smoked dose of THC is between the range of 0.10 and 0.25."*

[10] *"Bioavailability following the smoking route was reported as 2–56%, due in part to intra- and inter-subject variability in smoking dynamics, which contributes to uncertainty in dose delivery. The number, duration, and spacing of puffs, hold time, and inhalation volume, or smoking topography, greatly influences the degree of drug exposure."*

[8] *"The apparent absorption fraction calculated in the current study was in a similar range of previous findings on THC, showing an oral bioavailability of 6 %, and inhalation of 18 % (frequent smokers) or 23 % (heavy smokers)."*

[5] *"A systemic bioavailability of 23 ± 16% and 27 ± 10% for heavy users versus 10 ± 7% and 14 ± 1% for occasional users of the drug was reported."*

[7] *"Pulmonary bioavailability varies from 10 to 35 percent of an inhaled dose and is determined by the depth of inhalation along with the duration of puffing and breath-holding."*

Studies related to β

The role of the blood brain barrier (BBB) in THC and 11-OH-THC uptake is an important factor in determining equivalencies, as this function limits the flow of THC between the body's blood plasma and the brain, where it creates the psychoactive effects. As previously indicated, where THC is allowed to penetrate the BBB, the rate of penetration is slow. Below is a section from M. Huestis (2007)[10], that highlights the difficulty of THC passing through the BBB:

"Adams and Martin studied the THC dose required to induce pharmacological effects in humans. They determined that 2–22 mg of THC must be present in a cannabis

cigarette to deliver 0.2–4.4 mg of THC, based on 10–25% bioavailability for smoked THC. Only 1% of this dose at peak concentration was found in the brain, indicating that only 2–44 µg of THC penetrates to the brain." [Section 2.2: Distribution]

The competition between blood plasma concentrations and brain tissue concentrations is described by researchers as hysteresis, an indication that the cognitive effects of THC do not occur immediately when THC blood-plasma levels are elevated, but instead, they occur after the THC has been absorbed by various body tissues (primarily, the brain). The dosing effects are said to occur after the blood level and tissue THC concentrations are equal. The following passage from Cone and Huestis (1993) describes this:

"THC is rapidly absorbed and distributed to tissues; initial changes in blood concentrations are out of phase (hysteresis) with physiological and behavioral changes. Once blood/tissue equilibrium is established, a direct correlation of THC blood concentration and effect is observed." [Abstract]

Several studies that were motivated by THC driving impairment purposes have measured the rate of blood plasma clearance. An example is Hartman, et. al. (2015), this team measures the blood plasma clearance for THC after dosing THC using a vaporizing pen. The early clearance of THC was shown to be rapid, with concentration rates falling from a peak of 60 µg/liter 10 minutes after dosing, down to 15 µg/liter 30 minutes after dosing (and 20 minutes after the peak), and then to approximately 8 µg liter 90 minutes after dosing. Small levels of THC can be observed up to seven days after dosing.[13]

Based upon the slow BBB permeability, and the relatively rapid blood clearance rate, this study assumes that only a portion, equal to 35 percent, of THC blood plasma levels end up being absorbed by receptors in the brain when smoking. The comparative rate for ingestion will be much higher, as the liver metabolizes THC more slowly, leading to a long, sustained level of blood plasma THC and 11-OH-THC.

Studies related to θ

The process of THC absorption through ingestion is more straightforward. While there can be variation in this value, depending upon the stomach contents, rate of metabolism and a number of other factors [2,13]. Grotenhermen and Schwilke et al. find that the rate lies between 6-12 percent absorption, while Borgelt, Franson, Nussbaum, and Wang suggest that the rate is between 5-20 percent, with the rates typically on the lower range of absorption. Given this information, this study assumes 10 percent as a reasonable rate of THC absorption through ingestion. [2, 6, 13] These studies conclude that the absorption rate of THC through oral administration will be typically be less than that of smoking, with metabolism of THC into 11-OH-THC in the liver as a key factor in the low absorption of THC in this process.

13 Most of this literature is motivated to identify specific cutoff points to be considered legally "intoxicated" by THC and similar compounds. A non-psychoactive derivative of THC is 11-nor-9-carboxy-THC (THC-COOH), which is the most common trace substance used to detect marijuana use. New research focuses upon THC and 11-OH-THC since allowable levels are now needed, rather than presence alone. Colorado, for example, has a 5 µg/liter "permissible inference" law, as a cutoff value for legal intoxication of marijuana.

A WORKED EXAMPLE

For concreteness, a worked example is provided in Table IV-4. This example compares the uptake ratios for THC derivatives for 100 milligrams of THC that is either inhaled or ingested.

The result from Table IV-4 is that the equivalency ratio, R, equals 5.71, after findings from the medical literature are used to calibrate each of the uptake ratio parameters. This means that one milligram of THC in edible form, is equivalent to 5.71 milligrams of THC that is available in smokable form.

In the example above, which is based upon observations taken from metrc™, marijuana flower, or bud, has an average potency of 17 percent.[14] This implies that just over 0.5 grams (588 milligrams) of typical marijuana flower in Colorado contains 100 milligrams of THC (or THCa). From the worked example, an equivalent 100 milligrams of THC from an edible product would yield the equivalent effect of 3,361 milligrams (or 3.36 grams) of marijuana in flower form.

Due to each of the pharmacokinetic effects that are presented in this study, 100 milligrams of THC content in a smokable form, yields 7.88 milligrams of THC into the brain itself. In contrast, 100 milligrams of THC content in edible form yields a much higher ratio of 45.0 milligrams.

14 Based upon 28,023 laboratory test samples reported between October 2014 and May 2015.

Table IV-4. Example of Marijuana Equivalency Between Inhaled and Ingested Uptake Methods

Differential Uptake Equivalency: Inhaled vs. Ingested THC 100 mg Example			
Inhaled THC from Marjiuana Flower		**Ingested THC from Edible**	
THC in Smokable Flower	100	Edible Package: (100 MG)	100
THC Content	17%	Rate of Absorption	10%
% of Content Inhaled	50%	THC absorption (mg)	10
% of Inhaled Air Exhaled	45%	11-OH-THC Conversion	3.5
Gross THC Absorption (mg)	22.5	11-OH-THC / THC Equivalent:	35.00
Blood Cycle De-Rate Factor	35%		
Effective THC Infusion to Brain (mg)	7.88	Effective THC Infusion to Brain (mg)	45.00
Equivalencies			
Flower Weight (mg)	588	Flower Weight Equivalent (mg)	3,361
THC Equivalancy Ratio	1	THC Equivalency Ratio	5.71

Source: Author's calculations, combined with published medical research findings and statistical data from metrc™.

Figure IV-5. Conversion Factors between Marijuana Flower Weight and Non-flower Product Units

Conversion Factors		
Edibles (Weight to 10mg Units)		
0.25 Oz of Flower equals:	21	10mg Edible Units
1 Oz of Flower equals:	83	10mg Edible Units
1 Gram of Flower equals:	3	10mg Edible Units
Concentrates (Weight to Weight)		
0.25 Oz of Flower equals:	1.9	Grams Concentrate
1 Oz of Flower equals:	7.7	Grams Concentrate
1 Gram of Flower equals:	0.3	Grams Concentrate
Potency (THC share of weight)	62%	Based upon metrc™ Data

Source: Author's calculations, combined with medical literature findings and metrc™ data.

As discussed earlier, this is caused by a number of factors, including the time-curve of THC and 11-OH-THC blood-plasma levels in the blood and the share of that THC that can pass through the blood brain barrier.

RESULTING EQUIVALENCY TABLES

For policy purposes, Table IV-5 is constructed to compare different quantities of flower to their equivalent edible serving sizes. Concentrates are also included, using the average potency found from laboratory testing in Colorado between October 2014 and May 2015.

The equivalency ratio, R, can now be combined with THC content in various products, in order to construct more user-friendly conversion factors between product types. Table IV-5 lists common weights of marijuana flower that are purchased from retail and medical outlets in Colorado. Next to these weights are the number of units, based upon serving size, that are considered "equivalent" from a dosing perspective. For example, the purchase limit for an out-of-state patron at a retail marijuana store is one quarter of one ounce. This purchase limit would correspond to 21 units or servings of THC in edible form. If the edible is packaged in 100 milligram packages, then two 100 milligram packages could be purchased, plus one 10 milligram unit. That would fulfill the patron's daily limit purchase amount of marijuana.

For enforcement purposes, residents and non-residents alike are allowed to possess up to one ounce of marijuana flower at a given time. This one ounce amount corresponds to 83 units or servings of edible products. It can be packaged in the form of eight 100 mg packages of servings, plus three 10 mg additional individually-wrapped servings.

One gram of smokable marijuana corresponds to three 10 mg servings of edible products.

Of course, any combination of these amounts is also possible. For example, an out of state patron can purchase 1/8 ounce of marijuana flower, and can also purchase 10.5 servings (105 mg) of THC in edible form. Similarly, a resident who is 21 years or older could legally possess ½ ounce of marijuana flower, plus another 41.5 servings of THC in edible form.

For concentrates, the ratio of concentrate THC to flower THC is "one to one," because both are inhaled. Thus, the conversion factors between smoked concentrates (e.g., "dabbing") and smoked flower products are based solely upon the THC potency embodied in the weight of

the product itself. In Colorado, the average concentration ratio for wax or shatter type concentrates was 62 percent, based upon data collected between October 2014 and May 2015. Using this ratio, combined with the 17 percent average THC ratio in Colorado marijuana flower, the smoked THC conversion factors can be easily computed. For example, using the concentrate to flower THC ratios above, the result is 62/17 = 3.65.

For concentrates, the daily limit corresponding to one-quarter ounce of flower, is 1.9 grams of wax or shatter concentrate. Similarly, one ounce of flower equals 7.7 grams of concentrate, and one gram equals 0.3 grams of concentrate.

OILS, TINCTURES, LOTIONS, AND LESS COMMON UPTAKE METHODS

In Colorado, the share of edibles and concentrates in total demand has increased substantially. This demand growth precipitated the need for further regulatory oversight for these products. There also exists a large array of additional uptake methods for consuming marijuana. These include the sublingual approach (using tinctures), dermal (using lotions), and intravenous, among other methods.

These methods are not considered here, because a full investigation into each method is beyond the scope of this report, and because the current demand levels for these methods are relatively low. If the demand shares for these methods grows and becomes more important, then some investigation is warranted.

Market Price Comparison

There is a third method to consider equivalencies between marijuana products in Colorado's retail marijuana market. This is the "market price equivalency" method. From an economic viewpoint, this method is considered to be more direct than other methods, because it compares the price per unit of THC across different products, thereby reflecting the price that consumers are willing to pay—on a THC basis—for each product type.

Until now, it was not possible to compare market prices based upon THC content. By using mandated potency tests for flower and concentrates, an average potency rate can be applied, and then compared to edibles, which are marketed with fixed levels of THC content. Prices for marijuana products are easily found on most storefront websites.

Unlike many retail consumption products, the market for marijuana is relatively homogeneous. This is different from tobacco, where consumers identify products by brand name (Marlboro, or Camels). The homogeneity of marijuana suggests that market pricing should be based primarily upon the potency of the drug, rather than by advertising or marketing influences.

Most consumers of marijuana are purchasing the product for its psychoactive properties. To the extent that the product supplies more doses, the supplier can sell the product at a higher price. Therefore, from an economic viewpoint, there should be a positive, and relatively linear, relationship between the psychoactive ingredient provided by marijuana products and the price paid for it. This relationship can be compared across different product types, and used as supporting or detracting evidence for the dosage equivalencies computed in the previous section.

Recent marijuana prices were obtained from various Colorado vendors, and a table of representative prices has been constructed. The product menu in Figure V-6 on the following page displays typical marijuana products and prices for the Colorado recreational market.

How do we know that this product menu is "representative" of other menus along the Front Range? From an economic viewpoint, this menu is "representative" because the market for marijuana is relatively competitive. If this menu were significantly more expensive, or significantly less expensive than other menus, then the company would not sell much product, or they would be selling more product than they can produce in a given period.

Similarly, if the relative pricing between product types were skewed, then buyers would only purchase selected items that are relatively inexpensive, and they would not purchase the items that are relatively more expensive. So, in addition to being "representative" in gross price, the menu here is also representative in relative price—the relationship between prices from this menu will be similar to the offerings from most Colorado retail stores.

The prices listed in Table V-6 are displayed in terms of gross weight – either for marijuana flower or the weight of THC within a non-flower product. Until now, it was not possible to compare different products in Colorado, because there was no common denominator. However, using metrc™ data, this study finds the average potency of most popular marijuana strains to be quite narrow, between 16.5 and 17.7 percent of THCa. Therefore, we can use a midpoint value of 17 percent as the average expected potency in Colorado marijuana flower sold at the retail level.

Using this potency, the menu in Table V-6, listed in dollars per weight or unit, can be converted into a uniform menu, using the weight of THC (or THCa). The most convenient unit of measure is "cents per milligram of THC" (¢/MG_{THC}).

Figure V-6. Market Pricing for Marijuana Products in Colorado, Priced in Dollars by Weight or by Unit

Representative Recreational Menu Prices — June 15, 2015					
Flower	**Price by Weight ($USD)**				
	1 gram	1 eighth	1 quarter	1 half-oz	1 oz
Indica					
Ghost OG	14.03	41.27	82.54	148.58	264.14
Triangle Kush X Ghost OG	14.03	41.27	82.54	148.58	264.14
Sativa					
Glass Slipper	12.38	33.03	66.06	132.12	239.43
Hybrid					
White Master Kush	14.03	41.27	82.54	148.58	264.14
KING CHEM	12.38	33.03	66.06	132.10	239.43
Edibles	**THC MG**	**Price (each)**			
Highly Edible	100 mg	24.99			
Incredibles Boulder Bar	100 mg	23.11			
80 mg Dr. J's AM capsules	80 mg	19.81			
Gaia's Garden Garden Drops	80 mg	19.81			
Incredibles Peanut Budda	50 mg	19.81			
40 mg Blue Kudu Chocolate	40 mg	14.00			
Gaia's Garden Single Serving Lollipop	10 mg	6.60			
Gaia's Garden Single Serving Karma Kandy	10 mg	6.60			
Sweetgrass Snickerdoodle Cookie	10 mg	5.00			
Concentrates	**THC MG**	**Price (g)**			
O-Pen Vape Cartridge	500 mg	66.00			
Co_2 Oil		61.92			
Mahatma Shatter		61.92			
TC Labs Shatter (Strain Specific)		55.00			
O-Pen Vape Cartridge	250 mg	46.00			

Source: Marijuana storefront websites, accessed on June 15, 2015.

The price ratios shown in Table V-7 on the following page are notable because they reflect—quite closely—the pharmacokinetic results found earlier. That is, the standard market pricing for edibles, when compared by THC content, has a 3:1 ratio, just as the product equivalency tables would suggest. This means that although the market participants may not have completed their own pharmacokinetic research, they naturally have gravitated toward this result, based simply upon trial and error.

Of course, there are some products at the edge of the pricing structure, where the price ratio for THC is higher than 3:1. For example, the "Single Serving Lollipop" is priced at 66 ₵/MG_{THC}, which results in an 8:1 ratio. This pricing relates mostly to the fact that pricing for very small servings (e.g., single servings) have a lower bound, due to packaging and marketing. The price of a single serving lollipop is $6.60, mainly due to a lower price bound for marijuana products in general. Products that contain more than a single 10 mg serving of THC are all priced more closely to the 3:1 ratio than the single-serving units.

To summarize, the market price method for equivalency supports our earlier pharmacokinetic work. Market forces have led to a pricing structure that reflects a roughly 3:1 ratio between smoked THC products and edible THC products.

Figure V-7. Comparison of Market Pricing Between Flower and Non-flower Products, Priced in Cents per Milligram of THC Content

Representative Recreational Menu Prices — June 15, 2015					
Flower	**Price: Cents per mg THC**				
	1 gram	1 eighth	1 quarter	1 half-oz	1 oz
Indica Strains					
Ghost OG	8.25	6.94	6.94	6.24	6.10
Triangle Kush X Ghost OG	8.25	6.94	6.94	6.24	6.10
Sativa Strains					
Glass Slipper	7.28	5.55	5.55	5.55	5.53
Hybrid Strains					
White Master Kush	8.25	6.94	6.94	6.24	6.10
KING CHEM	7.28	5.55	5.55	5.55	5.53
Edibles	**Price: Cents per mg THC**		**Price Ratio: (per 1 g of Ghost OG)**		
Highly Edible	100 mg	24.99	3.03		
Incredibles Boulder Bar	100 mg	23.11	2.80		
80 mg Dr. J's AM capsules	80 mg	24.76	3.00		
Gaia's Garden Garden Drops	80 mg	24.76	3.00		
Incredibles Peanut Budda	50 mg	39.62	4.80		
40 mg Blue Kudu Chocolate	40 mg	35.00	4.24		
Gaia's Garden Single Serving Lollipop	10 mg	66.00	8.00		
Gaia's Garden Single Serving Karma Kandy	10 mg	66.00	8.00		
Sweetgrass Snickerdoodle Cookie	10 mg	50.00	6.06		
Concentrates	**Price: Cents per mg THC**		**Price Ratio: (per 1 g of Ghost OG)**		
O-Pen Vape Cartridge	500 mg	18.86	2.28		
Co_2 Oil		9.53	1.15		
Mahatma Shatter		9.53	1.15		
TC Labs Shatter (Strain Specific)		8.46	1.03		
O-Pen Vape Cartridge	250 mg	26.29	3.19		

Note: Conversions based upon average potency for flower and concentrate products in Colorado, determined through required testing of flower and concentrates.

Source: Colorado storefront menus, accessed on June 15, 2015.

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Terms & Acronyms

Butane hash oil ("BHO, dabs, shatter, wax") — A non-polar hydrocarbon which is used as a solvent in many other industries such as essential oil extraction, butane is especially well-suited for stripping cannabis buds or trim of their cannabinoids, terpenes, and other essential oils while leaving behind the majority of unwanted chlorophyll and plant waxes. In this extraction method, the solvent washes over the plant material and is then purged off from the resulting solution using a variety of techniques and variables such as heat, vacuum and agitation.

Cannabinoid — any of the chemical compounds that are the active principles of marijuana. Cannabinoids include THC, THCa, CBD, CBDa, CBN, and other naturally occurring compounds.

CO_2 extraction — When high pressure is applied to CO2, it becomes a liquid that is capable of working as a solvent, stripping away cannabinoids and essential oils from plant material. This process is called supercritical extraction and is the most common method of making hash oil using CO_2 instead of a hydrocarbon solvent such as butane. CO_2 extractions can take many of the same textures as BHO, but generally they tend to be more oily and less viscous.

Concentrate — Refers to any product which refines flowers into something more clean and potent. This umbrella term includes any type of hash, solventless (kief), as well as any hash oils (BHO, CO_2 oil, shatter, wax, etc.) and indicates that these products are a concentrated form of cannabis, carrying a much higher potency.

Decarboxylate — The process of converting THCa and CBDa into THC and CBD is an essential part of the process if you wish to consume cannabis orally. Decarboxylation occurs at around 240 degrees Fahrenheit, converting THCa and CBDa into THC and CBD, respectively. Though the acid forms of these cannabinoids have some medicinal benefits, normally decarboxylation is desired for maximum potency and effect in edibles and other infused products.

Infused product — A marijuana product which is intended to be consumed orally, including but not limited to, any type of food, drink, or pill.

Edibles — Any cannabis product which is consumed orally and digested is considered an edible.

Hydrocarbon extractions — Any extraction process that uses hydrocarbons such as butane or propane.

metrc™ — Marijuana Enforcement Tracking, Reporting and Compliance is the required seed-to-sale tracking system that tracks Retail Marijuana from either the seed or immature plant stage until the Retail Marijuana or Retail Marijuana Product is sold to a customer at a Retail Marijuana Store or is destroyed.

Marijuana Infused Product manufacturer ("MIP") — An entity licensed to purchase Retail Marijuana; manufacture, prepare, and package Retail Marijuana Product; and sell Retail Marijuana and Retail Marijuana Product only to other Retail Marijuana Products Manufacturing Facilities and Retail Marijuana Stores.

Supercritical extractions — When a substance is heated and pressurized beyond its critical point, it turns into a supercritical fluid capable of working as a solvent to strip away oils and essential compounds. It is used in a variety of industries for botanical extractions with several different types of fluid, but in the cannabis world, it generally refers to CO2 extractions. Supercritical extraction by nature is not particularly selective in terms of what it extracts, so many CO2 processors need to utilize a secondary solvent such as ethanol or hexane in order to remove waxes and chlorophyll prior to delivering a finished product.

THC — Tetrahydrocannabinol (THC) is the main cannabinoid found in the cannabis plant and is responsible for the majority of the plant's psychoactive properties. THC has lots of medical benefits including analgesic properties, though perhaps its most defined quality is its tendency to increase appetite. CBD acts as an antagonist to THC, reducing its psychoactive effects.

THCa — Tetrahydrocannabinolic acid (THCa) is the most prominent compound in fresh, undried cannabis.The compound does not have psychoactive effects in its own right, unless it is decarboxylated and converted into THC.

Trim — After harvest, the cannabis plant is generally trimmed of its leaf matter, leaving behind only the buds. Trimming refers to the actual act of removing the leaves, while trim refers to the leftover leaves, which can be used for making concentrates and infused products.

Vacuum purge — After extraction, most concentrates require further refining in order to remove the solvent which is remaining in the product. In order to do this, concentrate makers have utilized vacuum ovens and devices which serve to reduce the atmospheric pressure on the concentrate, which speeds up the process of removing the solvent.

STATE	***Possesion Limits***
	Possession limits for Adult Use (if relevant)
Sample	*20 g or cannabis* *8 g of concentrated cannabis* *Link to statute/rule*
Alabama	N/A
Alaska	Persons 21 years of age or older may posess -one ounce or less of marijuana -6 or fewer plants with three or fewe being mature, flowering plants -no more than 12 marijuana plants, with 6 or fewer being mature, may be present in a single dwelling AS 17.38.020
Arizona	One ounce or less of marijuana, except that not more than five grams of marijuana may be in the form of marijuana concentrate A.R.S. § 36-2852
Arkansas	Medical patients can purchase up to 2.5 ounces every 14 days (rolling allotment).
California	28.5 grams of cannabis or 8 grams concentrated cannabis (HSC §§11357 & 11362.1)
Colorado	2 oz of marijuana Section 18-18-406(4)(c), C.R.S.
Connecticut	five ounces of cannabis plant material (or equivalent) in a locked container at such person's residence or a locked glove box or trunk of such person's motor vehicle. An individual's personal possession limit does not include any live plant or cannabis plant material from any live plant they cultivate C.G.S. 21a-279a(a).
Delaware	1 ounce or less of cannabis, 12 grams or less of cannabis concentrate
District of Columbia	2 oz
Florida	**N/A.**
Georgia	**N/A**
Guam	1 ounce or less of cannabis, 8 grams or less of cannabis concentrate, or any cannabis-infused products containing eight hundred (800) mg or less of tetrahydrocannabinol
Hawaii	N/A
Illinois	**IL resident: 60g cannabis flower, no more than 1000mg THC in an infused product, 10g concentrate** **https://ilga.gov/documents/legislation/PublicActs/104/104-0463.htm** **Out of state resident: 60g cannabis flower, 5g concentrate, 500mg THC in an infused product**
Iowa	N/A
Kentucky	N/A
Louisiana	**None**

Maine	28-B: Chapter 3 §1501 1. B. 1. Authorized conduct. Except as otherwise authorized by this Title, a person 21 years of age or older may: B. Use, possess or transport at any one time up to 2 1/2 ounces of cannabis or 2 1/2 ounces of a combination of cannabis and cannabis concentrate that includes no more than 10 grams of cannabis concentrate.
Maryland	Effective July 1, 2023: 1) up to 1.5 oz of usable cannabis; 2) up to 12 grams of concentrated cannabis; 3) cannabis products containing up to 750 milligrams of delta-9 THC; and 4) up to two cannabis plants, capped at 2 plants per household COMAR 14.17.01.01(B)(39)
Massachusetts	1oz on person (only 5g can be concentrate). G. L. c. 94G § 7(a)(1)); up to 10oz in residence. G. l. c. 94G, § 7(a)(2).
Michigan	2.5oz on person (only 15g can be concentrate) 10oz in residence 12 marihuana plants at residence MCL 333.27955
Minnesota	Cannabis flower: 2oz or less in public, 2lb or less at a private residence. Cannabis concentrate: 8 grams or less of in public. Edible cannabis products: 800mg or less of total THC. Minn. Stat. § 342.09 subd. 1. Medical cannabis patients exempt from possession limits if products are properly labeled.
Mississippi	**N/A**
Missouri	**Consumers** who do not cultivate, may possess up to three (3) ounces of dried, unprocessed marijuana product, or its equivalent **Consumer Cultivators** who cultivate a supply of marijuana cultivated in excess of the consumer's three (3) ounce limit must keep the amount in excess in an enclosed, locked facility at a private residence. 19 CSR 100-1.040(4)(A)2 Additional information regarding purchase and possession limits can be found on the DCR Communication & Resource Center page. Information regarding Missouri Marijuana Equivalency Units (MME) can be found on the Patient and Consumer FAQ page.

Montana	As of January 1, 2021, adults 21 and over may possess and use up to one ounce of marijuana with no criminal penalties. Use of marijuana in a public place is prohibited and can result in a civil fine not to exceed $50. MCA 16-12-106(4).
Nebraska	
Nevada	2.5 ounces of usable cannabis, 1/4 ounce of concentrate, or a combination of the 2.
New Hampshire	N/A
New Jersey	One ounce of usable "cannabis", the quivalent of one ounce of usable cannabis as a product in solid, liquid, or concentrate form, or 5 grams of cannabis resin (legal), but up to 6 ounces of "marijuana" (illegal) is decriminalized. N.J.S.A. 2C:35-10a; N.J.S.A. 2C:35-10
New Mexico	Two ounces of cannabis, sixteen grams of cannabis extract and eight hundred milligrams of edible cannabis 26-2C-3 (4)(a)
New York	adults 21 can grow up to three (3) mature and three (3) immature plants at any one time but no residence can have more than six (6) mature and six (6) immature plants. You can have up to five (5) pounds of trimmed cannabis and the equivalent weight in concentrates in or on the grounds of their private residence. Individuals can carry and transport up to three (3) ounces of cannabis and 24 grams of concentrates within the state.
North Dakota	N/A
Ohio	Plant material: 2.5 ounces Concentrate: 15 grams
Oklahoma	N/A
Oregon	- 8oz usable marijuana, - 16oz solid cannabinoid product, - 72oz liquid cannabinoid product, - 16oz concentrates, - 1oz extracts (ORS 475C.337)
Pennsylvania	N/A
Rhode Island	Up to one (1) ounce on person 21+. n adult's primary residence up to ten (10) ounces per adult resident, plus up to 3 mature plants and 3 immature plants per dwelling unit, see R.I. Gen. Laws § 21-28.11-22.
South Dakota	**N/A**
Tennessee	**N/A - Hemp only**
Texas	**N/A**
Utah	**N/A**

Vermont	1 oz. cannabis 5g grams of hash. 18 V.S.A. § 4230(a).
Virginia	1 ounce in public Unlimited in private residence Possession of 1oz to 4oz of cannabis is subject to a civil fine of $25 dollars. More than four ounces and up to one pound of cannabis on one's person or in a public place is a criminal offense and can be a class 2 or class 3 misdemeanor. Over one pound of cannabis is considered a felony and can result in a prison sentence of one to ten years and a fine of up to $250,000. (https://law.lis.virginia.gov/vacode/title4.1/chapter11/section4.1-1100/)
Washington	Any combination of: 1oz useable cannabis, 16oz solid form cannabis-infused product, 72oz liquid form cannabis-infused product, or 7g cannabis concentrate (RCW 69.50.4013(3)(a)); (RCW 69.50.360(3)(a-d))
West Virginia	N/A
Wyoming	**N/A**
US Virgin Islands	An adult over 21 and who is not a qualified patient may possess up to : a. 2 ounces of Cannabis; b. 14 grams of Cannabis Concentrate; and c. 1 ounce of Cannabis Products
Cannabionid Hemp only	
Adult use state	
Medical state	

Cannabis Products and Equivalence

Sample Type	Flower Equivalence Constant
Flower (Product)	Weight of material
Concentrate (Final Product)	X 5.3*
Edibles	Σ (Amount of Cannabis Ingredient × Flower Equivalence Constant)**
Topicals, Oromucosal or Sublinguals, powder, Oral Muscosal Ointments, pills or tablets, Rosin	Σ (Amount of Cannabis Ingredient × Flower Equivalence Constant)**
Beverages	Σ (Amount of Cannabis Ingredient × Flower Equivalence Constant)**
Liquid Ingredient, Tinctures, Emulsions	Σ (Amount of Cannabis Ingredient × Flower Equivalence Constant)**
Prerolls with Added Distillate or Isolate	Σ (Amount of Cannabis Ingredient × Flower Equivalence Constant)**
Kief	X 5.3*
Pre-rolls, Solventless-infused Pre-rolls	Weight of material
Shake and Trim	Weight of material
Non-oral Muscosal Ointments and Lubricants, Suppositories	Σ (Amount of Cannabis Ingredient × Flower Equivalence Constant)**
Vape product	Σ (Amount of Cannabis Ingredient × Flower Equivalence Constant)**

**5.3 = 1 ÷ 0.19, based on the historical Massachusetts assumption that cannabis resin/concentrate represents a 19% yield from starting plant material. Historical DPH protocol gives the example that 1.9 oz of concentrate corresponds to 10 oz of flower-equivalent usable marijuana.*

***Weight of each cannabis ingredient used in the Production Batch × applicable Flower Equivalence Constant; sum the resulting values.*

Equivalencies in Marijuana Products Required for Compliance with Chapter 65

Recommendation:
Set the equivalent of 1 ounce of Marijuana Flower to 8 grams of Marijuana Concentrate and reflect the amendment throughout all Marijuana Products.

Issue:

The Commission must now determine the overall equivalencies of all products in the state.

Laws: (*Italicized for emphasis*)

- **Chapter 65 of the Acts of 2026 (Chapter 65)**:
  G.L. c. 94G, Section 4(a1/2)(xxxix)The Commission shall create regulations including: *"equivalency and conversion standards for marijuana products pursuant to subsection (a) of section 7, provided; however, that such standards shall consider potency and form*".

- **Old Limit**: (Clause (1) of subsection (a) effective until April 19, 2026)
  Persons 21 years or older shall not be arrested, prosecuted, penalized, sanctioned or disqualified under the law for: possessing, using, purchasing, processing or manufacturing 1 ounce or less of marijuana, *except that not more than 5 grams of marijuana may be in the form of marijuana concentrate*. G.L. c. 94G, Section 7(a)(1).

- **New Limit**: (New law, as amended by Chapter 65, effective April 19, 2026)
  Persons 21 years or older shall not be arrested, prosecuted, penalized, sanctioned or disqualified under the law for: (1) possessing, using, purchasing, processing or manufacturing 2 ounces or less of marijuana *or the equivalent amount of marijuana products as determined by the commission*. G.L. c. 94G, Section 7(a)(1).

Analysis:
Chapter 65 removed the statutory equivalent of 1 ounce of Marijuana Flower to 5 grams of Marijuana Concentrate. As indicated above, the law was amended to now require the Commission to set the equivalencies for all products. The Commission is also required to amend its regulations to be consistent with the new statute as of April of 2027, which means that the board needs to set a standard for staff to implement into the regulations.

The following analysis is based on the Marijuana Equivalency in Portion and Dosage from Colorado, issued August 10, 2015. This report was the only similar report on Marijuana Product equivalencies that staff found in their research. The following information is taken directly from the Colorado report for review and consideration of the Massachusetts Cannabis Control Commission board.

In summary, the report found the equivalent for Marijuana Concentrates to 1 ounce of Marijuana Flower equates to anywhere from 6.9-8.5 grams of Marijuana Concentrate depending on the

method of extracting the THC and the potency of the Marijuana.
1 Oz of Flower equals:

Physical Equivalency: (by extraction method)
Concentrate – Butane: 6.91g
Concentrate – CO2: 8.07g
Concentrate – Ethanol: 7.37g
Concentrate – Water: 8.5g

Pharmacokinetic Dosage Equivalency: (Based on CO market average in 2015 of 17.1% THC)
Concentrate – 7.72g.

"Physical equivalencies were calculated in two ways – a THC equivalency, and a physical production equivalency. Physical equivalencies were calculated for the major concentrate and infused product manufacturing techniques, including butane hash oil, CO2 oil, ethanol, and water. Physical production equivalency were calculated by isolating the marijuana trim and shake inputs and determining a yield ratio. The THC methodology provides an equivalent amount of THC in various forms of marijuana products based on recent state testing information Table ES-1 shows equivalency factors for both methodologies by solvent type.

Pharmacokinetic equivalency incorporates findings from medical and pharmacological publications to inform marijuana stakeholders about the dosing process. The authors created a new mathematical construct that can compare ingested and smoked marijuana products in a consistent manner. The pharmacokinetic model compares inhaled and ingested products using a dose ratio. The calculations are based upon different uptake routes and speeds for the psychoactive compounds related to marijuana use (e.g., THC and 11-OH-THC)."

*It is important to note here that this report's analysis was done 11 years ago and uses a potency of 17% THC in Flower. This number is likely a lower number than the current Massachusetts average for THC percentage.

"Price ratios are notable because they match—quite closely—to the pharmacokinetic equivalency ratios. This means that although the market participants may not have completed their own pharmacokinetic research, they naturally have gravitated toward this result, based simply upon trial and error."

State by State Comparison: Please see the attached excel document from CANNRA.

Cannabis Control Commission

COMMONWEALTH OF MASSACHUSETTS

Study and Recommendations Regarding the Effective Regulation of the Hemp-Derived Cannabinoid Market in Massachusetts

December 2026

DRAFT

Massachusetts Cannabis Control Commission

in consultation with:
Massachusetts Department of Public Health
Massachusetts Department of Agricultural Resources
Massachusetts Department of Revenue
Massachusetts Alcoholic Beverages Control Commission

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Introduction

A. Legislative Mandate

Section 64 of *Chapter 65 of the Acts of 2026* directs the Massachusetts Cannabis Control Commission (Commission), in consultation with the Department of Public Health (DPH), the Department of Agricultural Resources (MDAR), local boards of health, the Department of Revenue (DOR), the Alcoholic Beverages Control Commission (ABCC), and other appropriate state agencies and departments, to conduct a study and develop recommendations regarding the effective regulation of the hemp-derived cannabinoid market.

The statute directs the Commission to evaluate a broad range of regulatory and policy considerations, including ongoing federal law and other statutory and regulatory developments, licensing conditions, testing requirements and standards, appropriate age restrictions and other safeguards against underage access, regulations for potential retail sales and taxation, and optimal procedures in other states that have undertaken regulation of ingestible hemp products. The Commission is further directed to publish the results of the study on its website and submit the completed report to the Clerks of the Massachusetts Senate and House of Representatives and the Joint Committee on Cannabis Policy no later than December 15, 2026.

Consistent with this mandate, this report does not endorse a single comprehensive regulatory framework. Instead, it presents a range of policy options, together with their potential benefits, risks, implementation considerations, fiscal implications, and statutory requirements, while identifying cross-cutting recommendations that may apply across multiple models, including preservation of MDAR's cultivation role, clear product definitions, risk-proportionate finished-product testing, safeguards against youth access, clear retail and online-sales requirements, separation of intoxicating cannabinoid sales from alcohol-only retail, enforceable recall and civil-compliance authority, and sufficient funding and staffing for responsible agencies.

B. Purpose

This report is organized into two parts. Part I provides the historical, legal, market, and comparative background necessary to understand the development and current regulation of hemp-derived cannabinoid products. Part II presents regulatory models and policy options for legislative consideration and addresses licensing, testing and product standards, retail sales, age and youth-access safeguards, taxation, enforcement, and additional public-health considerations. The report distinguishes between existing law and agency authority, current administrative guidance, practices adopted in other jurisdictions, and policy options that would require legislative action. Where appropriate, it also identifies issues that may be addressed through regulation or interagency coordination within existing statutory authority.

C. Scope

This report examines the national hemp-derived cannabinoid market with particular attention to the legal and policy questions presented in Massachusetts. It addresses products currently available in

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commerce, including non-intoxicating and intoxicating cannabinoids and the principal product forms through which consumers encounter them. The inclusion of products currently available in commerce does not indicate that their manufacture, distribution, or sale is lawful under existing federal or Massachusetts law. Certain products discussed in this report are already prohibited or subject to restrictions under applicable laws and regulations. The report considers federal and state law, licensing and registration structures, testing and product standards, age and youth-access safeguards, retail channels, taxation, enforcement, public-health considerations, and regulatory approaches adopted by other states.

Agricultural hemp cultivation is discussed where necessary to explain the supply chain and agency jurisdiction, but the report does not propose transferring the Commonwealth's hemp cultivation program from MDAR. Under federal law, hemp production must occur pursuant to an authorized state or Tribal production plan or through the federal licensing program administered by the United States Department of Agriculture (USDA).[1] The federal amendments discussed in this report do not eliminate these requirements. Accordingly, any proposed changes to the Commonwealth's regulation of hemp-derived cannabinoid products should distinguish the existing federal framework governing hemp cultivation from the regulation of downstream processing, manufacturing, distribution, and retail activities. The report also does not attempt to comprehensively address every question involving marijuana regulation, pharmaceutical cannabinoid products, or industrial uses of hemp unrelated to cannabinoid consumer products except where those subjects are necessary to evaluate the effective regulation of the hemp-derived cannabinoid market.

D. Definitions

For the purposes of this report, terms are used descriptively unless a statute or regulation is specifically cited.

- "**Hemp-derived cannabinoid product**" refers generally to a finished product containing one or more cannabinoids derived from hemp and intended for human or animal use.
- "**Ingestible hemp product**" refers to foods, beverages, tinctures, capsules, gummies, and other products intended to be swallowed or otherwise consumed.
- "**Intoxicating cannabinoid**" refers to a cannabinoid capable of producing intoxicating or psychoactive effects at a commercially relevant dose.
    i. "**Chemically converted cannabinoid**" refers to a cannabinoid produced through a chemical conversion process from another cannabinoid, including conversion from hemp-derived cannabidiol (CBD).
- "**Total THC**" refers to a measurement that accounts for delta-9 tetrahydrocannabinol (THC) and applicable precursor compounds, including tetrahydrocannabinolic acid (THCA), as specified by the governing law or testing method.

These working definitions are intended to provide consistency throughout the report and do not

[1] *See* 7 U.S.C. §§ 1639p–1639q (establishing state and Tribal hemp production plans and federal hemp production licensing); *see also* 7 C.F.R. pt. 990 (establishing USDA regulations governing domestic hemp production).

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supersede definitions established by federal or Massachusetts law.

E. Methodology and Interagency Coordination

The Commission conducted legal and policy research that included review of federal and Massachusetts statutes, regulations, and agency guidance; laws and regulatory frameworks adopted in other jurisdictions; market and economic analyses; and selected scientific and public-health literature. The Commission also examined legislative activity and regulatory models in other states to identify recurring approaches to product classification, licensing, testing, age restrictions, retail sales, taxation, enforcement, and product recalls.

Consistent with Section 64 of *Chapter 65 of the Acts of 2026*, the Commission consulted with the DPH, MDAR, DOR, ABCC, and other appropriate agencies and stakeholders. The report distinguishes existing agency authority from proposals requiring additional statutory authority and incorporates agency feedback where relevant to the regulatory options presented.

The study is subject to certain limitations, including rapidly evolving federal and state law, inconsistent terminology and regulatory classifications among jurisdictions, and variations in the availability and quality of market, enforcement, public-health, and consumer data. Research for this draft reflects legal and policy developments reviewed through September 2026. Where information was incomplete or evolving, the report identifies those limitations and relies on the best available information at the time of publication.

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Part I: Background and Current Hemp Landscape

A. History of Hemp Law and Policy

Federal regulation of cannabis predates modern hemp policy and the legal distinctions between what is lawfully defined as "hemp" and "marijuana.". Although commonly treated as separate categories, hemp and marijuana originate from the same cannabis plant, Cannabis sativa L., and their distinction is primarily established through statutory definitions rather than fundamental botanical differences. Historically, federal hemp legislation focused on permitting the cultivation of cannabis for agricultural and industrial purposes, including fiber and grain production, rather than for the manufacture of cannabinoid consumer products. These legal distinctions created separate regulatory pathways for cannabis plants and products based on their classification under applicable law. The Marihuana Tax Act of 1937 imposed registration, taxation, and recordkeeping requirements on cannabis transactions, while the Controlled Substances Act of 1970 (CSA) classified "marihuana" as a Schedule I controlled substance without establishing a separate federal category for low-THC hemp.[2] As a result, hemp cultivation remained subject to federal controlled-substance restrictions until Congress began authorizing limited industrial hemp research in 2014.

Congress first revisited federal hemp policy through the Agricultural Act of 2014 (2014 Farm Bill). Section 7606 of the Act authorized institutions of higher education and state departments of agriculture to cultivate industrial hemp for research purposes in states where such cultivation was permitted under state law.[3] Although the legislation did not broadly remove hemp from the CSA, it established a federal framework under which qualifying industrial hemp could be cultivated through authorized research and pilot programs. For purposes of those programs, Congress defined industrial hemp as Cannabis sativa L. containing no more than 0.3 percent delta-9 THC on a dry-weight basis.[4]

The 2014 Farm Bill prompted many states to establish industrial hemp research programs and pilot projects. Universities, agricultural agencies, and private participants began studying hemp cultivation practices, seed varieties, processing methods, and potential commercial applications. These programs demonstrate renewed interest in hemp as an agricultural commodity and provided policymakers with practical experience that informed subsequent federal legislation. Some states interpreted the 2014 Farm Bill to allow the commercial sale of hemp and hemp-derived products, thus setting the stage for early access to hemp-derived products under the guise of "research."

Congress substantially revised federal hemp policy through enactment of the Agriculture Improvement Act of 2018 (2018 Farm Bill).[5] The legislation fundamentally changed the legal status of hemp by removing qualifying hemp from the federal definition of marijuana under the CSA, recognizing it as an agricultural commodity, and excluding hemp-derived THC from Schedule I controlled-substance treatment, provided the material met the statutory definition of hemp.[6] Hemp and hemp-derived products meeting the federal definition were therefore no longer treated as a controlled

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[2] Marihuana Tax Act of 1937, ch. 553, 50 Stat. 551 (1937) (repealed 1970); Controlled Substances Act, Pub. L. No. 91-513, tit. II, 84 Stat. 1236 (1970) (codified as amended at 21 U.S.C. §§ 801–971).
[3] Agricultural Act of 2014, Pub. L. No. 113-79, § 7606, 128 Stat. 649, 912–14 (2014).
[4] *Id.* § 7606(b)(2), 128 Stat. at 913.
[5] Agriculture Improvement Act of 2018, Pub. L. No. 115-334, 132 Stat. 4490 (2018).
[6] *Id. §§ 12619–12620, 132 Stat. at 5018–21; 21 U.S.C. § 802(16)(B)(i).*

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substance solely because it originated from the cannabis plant.

The 2018 Farm Bill retained the 0.3 percent delta-9 THC threshold established in 2014 but broadened the federal statutory definition of hemp to include *Cannabis sativa* L. and any part of the plant, including its seeds, derivatives, extracts, cannabinoids, isomers, acids, salts, and salts of isomers, provided the delta-9 THC concentration did not exceed 0.3 percent on a dry-weight basis.[7] The express inclusion of derivatives, extracts, and cannabinoids was significant because the statutory definition extended beyond the agricultural plant itself to materials and compounds derived from qualifying hemp.

The 2018 Farm Bill also established a national regulatory framework for hemp production administered by the United States Department of Agriculture (USDA).[8] The legislation authorized state departments of agriculture and Tribal governments to assume primary regulatory responsibility for hemp production through USDA-approved plans and in accordance with applicable state and Tribal laws, while USDA would administer a federal licensing program in jurisdictions without approved plans.[9] Today, hemp production occurs under a combination of approved state, Tribal, and federal programs.

The federal production framework is distinct from the regulation of downstream activities including processing, manufacturing, distribution, and retail sales. While hemp cultivation must comply with applicable federal production requirements, states may establish separate regulatory requirements for the processing, manufacturing, and sale of hemp-derived cannabinoid products, subject to applicable federal law. This distinction is particularly relevant when considering whether responsibility for downstream cannabinoid activities should remain with agricultural regulators or be assigned to another designated agency.

The 2018 Farm Bill also addressed interstate transportation by prohibiting states and Tribal governments from preventing the transportation or shipment of lawfully produced hemp through their jurisdictions.[10] This protection facilitated the development of interstate supply chains in which hemp may be cultivated, processed, formulated into finished products, and distributed through across multiple jurisdictions before reaching consumers.[11] As a result, agricultural producers, processors, manufacturers, distributors, and retailers may participate in commercial markets that extend beyond individual state boundaries, distinguishing the hemp industry from many state-regulated cannabis markets. However, the scope and application of these federal transportation protections have been the subject of litigation, particularly where state restrictions on hemp or hemp-derived products intersect with federal interstate transportation requirements. These legal challenges highlight the complexities of distinguishing between the transportation of lawfully produced hemp and the regulation of downstream hemp-derived consumer products.

The 2018 Farm Bill did not, however, establish a comprehensive federal regulatory system for finished hemp-derived consumer products. Congress expressly preserved the authority of the United States Food and Drug Administration (FDA) under the Federal Food, Drug, and Cosmetic Act and

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[7] Agriculture Improvement Act of 2018 § 10113, 132 Stat. at 4908–14 (codified as amended at 7 U.S.C. § 1639o(1)).
[8] *Id.* §§ 10111–10113, 132 Stat. at 4908–18; 7 U.S.C. §§ 1639p–1639q.
[9] 7 U.S.C. §§ 1639p–1639q; Establishment of a Domestic Hemp Production Program, 86 Fed. Reg. 5596 (Jan. 19, 2021) (codified at 7 C.F.R. pt. 990).
[10] Agriculture Improvement Act of 2018 § 10114, 132 Stat. at 4919.
[11] Whitney Economics, *2026 U.S. Hemp Cannabinoid Report* (Sept. 1, 2026).

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related laws.[12] FDA's authority over cannabis-derived products applies regardless of whether the cannabinoids originate from hemp or marijuana, with applicable requirements determined by the product's intended use, formulation, ingredients, and regulatory classification.[13] Accordingly, removal of qualifying hemp from the CSA did not independently authorize the use of hemp-derived ingredients in food, dietary supplements, drugs, cosmetics, or other FDA-regulated products.[14]

This distinction became particularly significant as the commercial CBD market expanded. Following enactment of the 2018 Farm Bill, hemp-derived CBD became widely available in oils, tinctures, capsules, topicals, cosmetics, gummies, beverages, and other consumer products. FDA has continued to maintain that the Farm Bill did not alter the agency's authority over products within its jurisdiction and has taken enforcement action against certain products marketed with unapproved therapeutic claims or otherwise sold in violation of federal food and drug law.[15]

At the same time, advances in extraction, refinement, and chemical conversion contributed to the development of consumer products containing cannabinoids beyond CBD. Products containing delta-8 THC, hemp-derived delta-9 THC, delta-10 THC, hexahydrocannabinol (HHC), tetrahydrocannabiphorol (THCP), and other cannabinoids entered the national marketplace. Some of these cannabinoids occur naturally in the cannabis plant only in relatively small concentrations and may be produced at commercial scale through conversion or other manufacturing processes. As a result, the confusion about what is "naturally" versus "synthetically" derived and the legal implications of such created confusion amongst regulators, industry, and even the courts.

The emergence of intoxicating hemp-derived cannabinoid products significantly changed the market that developed after 2018. Products increasingly included formulations intended to produce intoxicating effects while relying on the federal definition of hemp based principally on delta-9 THC concentration that was established through a regulatory testing process only at the time of hemp harvest- and on a dry weight basis.[14] Thus, while products were created using federally compliant hemp as an ingredient, the end products could contain significantly higher amounts of delta-9 THC and other cannabinoids..[16] States responded through substantially different approaches, including age restrictions, potency and serving limits, testing and labeling requirements, retailer or product registration, restrictions on chemically converted cannabinoids, integration into existing cannabis regulatory systems, and prohibitions on certain product categories. National Conference of State Legislatures (NCSL) has similarly observed that responsibility for hemp and cannabis products is frequently divided among different state agencies and that state regulatory approaches vary considerably.[17] These changes, however, were only allowed to the extent they were consistent with state laws, something that presented a significant challenge to regulators trying to address issues in real time.

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[12] Agriculture Improvement Act of 2018 § 12619(b), 132 Stat. at 5021; Federal Food, Drug, and Cosmetic Act, 21 U.S.C. §§ 301–399i.
[13] U.S. Food & Drug Admin., *FDA Regulation of Cannabis and Cannabis-Derived Products, Including Cannabidiol (CBD)*.
[14] *See* 7 U.S.C. § 1639r(c); U.S. Food & Drug Admin., *FDA Regulation of Cannabis and Cannabis-Derived Products, Including Cannabidiol (CBD)*, Questions 2, 8–10, FDA guidance.
[15] U.S. Food & Drug Admin., *supra* note 13; U.S. Food & Drug Admin., *FDA Issues Warning Letters to Companies Illegally Selling CBD and Delta-8 THC Products* (May 4, 2022).
[16] Nat'l Conf. of State Legislatures, *State Cannabis Policy Enactment Database* (updated Sept. 14, 2026); U.S. Food & Drug Admin., *5 Things to Know About Delta-8 Tetrahydrocannabinol – Delta-8 THC*.
[17] Nat'l Conf. of State Legislatures, Regulating Hemp and Cannabis-Based Products (Apr. 30, 2022).

Federal policy changed again in November 2025. Congress enacted Section 781 of Division B of Public Law 119-37, amending the federal definition of hemp and establishing a substantially different framework for distinguishing hemp from federally controlled marijuana. [18]Among other changes, the legislation adopted a total-THC approach, addressed cannabinoids synthesized or manufactured outside the cannabis plant, and established a 0.4-milligram-per-container threshold applicable to specified final hemp-derived cannabinoid products. Subsequent federal legislation delayed application of most of those amendments until December 11, 2026, while certain provisions affecting non-naturally occurring or manufactured cannabinoids remained subject to an earlier effective date.[19]

These changes occurred immediately before the December 15, 2026 deadline for this report and represent a significant change from the federal framework under which much of the current hemp-derived cannabinoid marketplace developed. Secondary legal analysis has described the amendments as a major restructuring of the intoxicating hemp market and has identified potential consequences for existing inventories, interstate commerce, contracts, insurance, taxation, and businesses operating in states that continue to authorize hemp-derived cannabinoid products.[20] Advocacy organizations have separately argued that restricting currently available hemp-derived THC products without establishing a replacement regulatory framework could shift some consumer demand toward less regulated markets; those arguments are considered as stakeholder perspectives rather than independent findings of this report.[21]

The legal effect and implementation of the 2025 and 2026 federal changes, as well as their interaction with Massachusetts law, are discussed in greater detail in the following section.

B. Current Legal and Regulatory Landscape

1. Federal Law and Policy

The federal legal status of hemp-derived cannabinoid products is governed by several overlapping statutory and regulatory frameworks. Under the system established by the 2018 Farm Bill, Congress conferred the oversight of hemp production (i.e., cultivation) to the USDA including the approval of state and Tribal production plans and administration of a federal licensing program, which currently does not have an approved plan in place. The federal amendments enacted in 2025 and modified in 2026 do not alter this production framework, and hemp cultivation must continue to occur under an authorized USDA, state, or Tribal production program.[22] Although states may establish separate regulatory structures for downstream hemp-derived cannabinoid activities, such structures must remain consistent with applicable federal requirements.

Separately, the FDA retains authority under the Federal Food, Drug, and Cosmetic Act over foods, dietary supplements, drugs, cosmetics, animal products, and other products within its jurisdiction that

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[18] Continuing Appropriations, Agriculture, Legislative Branch, Military Construction and Veterans Affairs, and Extensions Act, 2026, Pub. L. No. 119-37, div. B, § 781, 139 Stat. 495, 559–61 (2025).
[19] Continuing Appropriations and Extensions Act, 2027, Pub. L. No. 119-103, div. B, § 2019, 140 Stat. 987, 1003 (2026).
[20] Ian A. Stewart, *The Great Hemp Reset: How the Federal Ban on Intoxicating Hemp Products Will Reshape Risk and Coverage*, Wilson Elser (Sept. 8, 2026).
[21] Drug Pol'y All., *Frequently Asked Questions About Federal Hemp Policy* (May 2026).
[22] *See* 7 U.S.C. §§ 1639p–1639q; Continuing Appropriations, Agriculture, Legislative Branch, Military Construction and Veterans Affairs, and Extensions Act, 2026, Pub. L. No. 119-37, div. B, § 781, 139 Stat. 495, 559–61 (2025); Continuing Appropriations and Extensions Act, 2027, Pub. L. No. 119-103, div. B, § 2019, 140 Stat. 987, 1003 (2026).

contain cannabis-derived ingredients.[23] The removal of qualifying hemp from the Controlled Substances Act (CSA) therefore did not independently authorize hemp-derived cannabinoids for use in products regulated by the FDA. The FDA has consistently maintained that the 2018 Farm Bill did not alter its authority over products within its jurisdiction, including foods and dietary supplements containing cannabidiol (CBD). Federal enforcement activity has also addressed products containing CBD and delta-8 THC, including products marketed with unapproved therapeutic claims and products that present manufacturing, labeling, or consumer-safety concerns.[24] Accordingly, whether a product qualifies as hemp under federal controlled-substance law does not independently determine whether it may lawfully be manufactured or sold as an FDA-regulated product.

Federal law changed substantially in November 2025. Section 781 of Division B of Public Law 119-37 amended the statutory definition of hemp to use a total-THC standard that includes THCA and established separate treatment for industrial hemp, intermediate hemp-derived cannabinoid products, and final hemp-derived cannabinoid products. The amendments exclude specified cannabinoids that are not naturally produced by *Cannabis sativa* L., cannabinoids that can occur naturally but are synthesized or manufactured outside the plant and specified final hemp-derived cannabinoid products containing more than 0.4 milligrams per container of combined total THC and other cannabinoids having, or marketed as having, effects similar to THC.[25]

The amendments were originally scheduled to take effect on November 12, 2026. Public Law 119-103 subsequently modified the implementation schedule so that most of the amendments do not apply until December 11, 2026, while specified exclusions involving cannabinoids that are not capable of being naturally produced by the cannabis plant became applicable on November 12, 2026.[26] The timing is particularly significant because the federal transition occurs only days before the Commission's December 15, 2026 reporting deadline and may change whether products currently marketed as hemp continue to qualify as hemp under federal law. Products that no longer satisfy the amended federal definition of hemp may instead fall within the federal definition of marijuana under the CSA. Many of the products on the market today that contain cannabinoids derived from hemp could fall under the definition of marijuana and would depend on the interaction between federal and state statutory definitions. In those cases, some hemp products would be captured under the existing marijuana regulatory oversight in the Commonwealth without additional legislative action.

Federal food and drug law remains independently applicable. FDA has consistently maintained that the 2018 Farm Bill did not alter its authority over products within its jurisdiction, including foods and dietary supplements containing CBD. Federal enforcement activity has also addressed products containing CBD and delta-8 THC, including products marketed with unapproved therapeutic claims and

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[23] Agriculture Improvement Act of 2018 §§ 10111–10114, 12619, 132 Stat. at 4908–19, 5018–21; Establishment of a Domestic Hemp Production Program, 86 Fed. Reg. 5596 (Jan. 19, 2021) (codified at 7 C.F.R. pt. 990); U.S. Food & Drug Admin., FDA Regulation of Cannabis, *supra* note 14.

[24] U.S. Food & Drug Admin., *FDA Issues Warning Letters to Companies Illegally Selling CBD and Delta-8 THC Products, supra* note 15; U.S. Food & Drug Admin., *supra* note 16.

[25] Continuing Appropriations, Agriculture, Legislative Branch, Military Construction and Veterans Affairs, and Extensions Act, 2026, Pub. L. No. 119-37, div. B, § 781, 139 Stat. 495, 559–61 (2025).

[26] Continuing Appropriations and Extensions Act, 2027, Pub. L. No. 119-103, div. B, § 2019, 140 Stat. 987, 1003 (2026).

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products that present manufacturing, labeling, or consumer-safety concerns.[27] Accordingly, whether a product qualifies as hemp for purposes of federal controlled-substance law does not by itself determine whether the product may lawfully be manufactured or sold as a food, dietary supplement, drug, or other FDA-regulated product.

The 2025 and 2026 amendments are expected to affect a substantial portion of the intoxicating hemp-derived cannabinoid market that developed under the 2018 framework. Secondary legal analysis has identified potential consequences involving existing inventories, interstate distribution, contracts, taxation, insurance, and the transition of businesses operating in states that have independently authorized hemp-derived cannabinoid products.[28] This report relies on enacted federal law for its legal conclusions and uses such secondary analysis to identify implementation and market-transition considerations.

2. Massachusetts Law and Agency Authority

The distinction between hemp and marijuana is primarily legal rather than botanical, with "hemp" being the term for cannabis that meets a certain legally defined delta-9 THC threshold, Massachusetts currently regulates hemp and hemp-derived products through several statutes and agencies rather than through a single comprehensive cannabinoid-product framework. MDAR administers the Commonwealth's hemp program pursuant to G.L. c. 128, §§ 116–123. Massachusetts law defines hemp using a THC standard that accounts for both delta-9 THC and THCA and authorizes MDAR to regulate hemp production, licensing, inspection, testing, and enforcement.[29]

MDAR's current role is principally focused on the production, processing, and wholesale portions of the hemp market. While hemp cultivation remains subject to the federally authorized production framework administered in Massachusetts by MDAR, the regulation of downstream processing and cannabinoid products is governed by separate state statutory and regulatory requirements. MDAR's published FAQ expressly states that it regulates the wholesale market, rather than direct-to-consumer retail sales, and does not require a retail establishment to obtain an MDAR license solely to sell hemp-derived products. At the same time, MDAR states that its product restrictions applicable to wholesale transactions generally apply to retail sales in Massachusetts as well.[30] MDAR currently identifies permitted and prohibited product categories through its policy statements and guidance, including restrictions involving CBD-containing foods, products making therapeutic claims, dietary supplements, animal feed, and certain raw hemp products.

The Commission's statutory authority intersects with hemp through G.L. c. 94G, § 12(f). That provision permits a licensed marijuana establishment to cultivate, manufacture, sell, or otherwise transact business in hemp and hemp products cultivated and manufactured pursuant to an MDAR

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[27] U.S. Food & Drug Admin., *FDA Concludes that Existing Regulatory Frameworks for Foods and Supplements Are Not Appropriate for Cannabidiol, Will Work with Congress on a New Way Forward* (Jan. 26, 2023); U.S. Food & Drug Admin., *FDA Issues Warning Letters to Companies Illegally Selling CBD and Delta-8 THC Products* (May 4, 2022); U.S. Food & Drug Admin., *5 Things to Know About Delta-8 Tetrahydrocannabinol – Delta-8 THC*.

[28] Stewart, *supra* note 20.

[29] Mass. Gen. Laws ch. 128, §§ 116–123; 330 Mass. Code Regs. 32.00 (2026); Mass. Dep't of Agric. Res., *Massachusetts State Hemp Plan – Revised 2021* (Aug. 27, 2021).

[30] Mass. Dep't of Agric. Res., *FAQs: Sale of Hemp-Derived Products in the Commonwealth*; Mass. Dep't of Agric. Res., *Policy Statement: Sale of Hemp-Derived Products in the Commonwealth* (Oct. 4, 2021).

license and in compliance with applicable USDA requirements.[31] *Chapter 65 of the Acts of 2026* further amended the statutory definition of marijuana to exclude "hemp," rather than only "industrial hemp," reinforcing the distinction between hemp under agricultural law and marijuana regulated by the Commission.[32]

Commission and MDAR guidance have further defined how hemp products may enter the regulated marijuana market. Commission guidance issued in 2021 permits Marijuana Retailers to purchase specified consumer-ready hemp products from MDAR-licensed processors. Under that guidance, such products are treated differently from regulated marijuana inventory: they must be displayed in a dedicated retail section, may not be sold to persons under 21, are not required to be tracked through the Commission's seed-to-sale system, and must be accompanied by specified consumer information explaining that the product was produced under MDAR's hemp program rather than regulated as a marijuana product by the Commission.[33]

MDAR guidance issued in October 2021 similarly established requirements for MDAR-licensed producers and processors selling hemp or hemp-derived products to Commission licensees. MDAR's guidance distinguishes between activities occurring within its hemp-production and processing jurisdiction and activities taking place within a Commission-licensed establishment. It also provides that a Commission licensee does not need an additional MDAR license merely to purchase or sell qualifying consumer-ready hemp products obtained from an MDAR licensee, although an MDAR processor license may be required if the Commission licensee separately manufactures a finished product to be marketed and sold as hemp.[34]

In 2023, the Commission and MDAR issued a joint bulletin further clarifying compliance requirements for Marijuana Establishments and medical marijuana licensees obtaining and using hemp products. Among other requirements, the bulletin states that Commission licensees may obtain hemp only from MDAR licensees; identifies product categories that may not be purchased or sold; establishes labeling and source-verification expectations; and requires specified testing where hemp products enter the Commission-regulated system. When hemp or hemp-derived material is used as an ingredient in a marijuana product, the resulting marijuana product remains subject to Commission testing and labeling requirements.[35]

These requirements illustrate an important distinction in the existing Massachusetts framework. MDAR does not generally license direct-to-consumer hemp retailers, but it regulates the licensed cultivation and processing sources from which qualifying hemp products originate. The Commission regulates activities occurring within Commission-licensed establishments, while DPH and other agencies retain authority over products and activities within their respective jurisdictions. The result is a system in which the applicable regulator may depend on the product form, how the product was manufactured, the entity selling it, and the retail channel through which it reaches the consumer. Any future proposal to assign downstream cannabinoid processing, manufacturing, distribution, or retail oversight to a different agency would need to distinguish those activities from MDAR's hemp

[31] Mass. Gen. Laws ch. 94G, § 12(f).
[32] Mass. Gen. Laws ch. 94G, § 12(f); Act of Apr. 19, 2026, ch. 65, § 12, 2026 Mass. Acts.
[33] Cannabis Control Comm'n, *Guidance for the Retail Sale of Hemp* (May 2021).
[34] Mass. Dep't of Agric. Res., *Sale of Hemp and Hemp-Derived Products to Marijuana Establishments* (Oct. 4, 2021).
[35] Cannabis Control Comm'n & Mass. Dep't of Agric. Res., *Bulletin: Obtaining and Using Hemp Products* (Oct. 10, 2023).

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cultivation responsibilities and identify any necessary changes to existing statutory authority, licensing requirements, and interagency coordination.

This division of authority became particularly significant for hemp-derived foods and beverages. In May 2024, DPH and MDAR issued a joint notice stating that food and beverages containing hemp-derived CBD or THC may not be manufactured or sold in Massachusetts under the food regulatory framework administered by DPH, while expressly distinguishing edible marijuana products manufactured and sold under the Commission's jurisdiction. The following day, ABCC issued an advisory directing alcoholic beverage licensees to remove food and beverages containing hemp-derived CBD or THC from licensed premises and advised that violations could result in licensing consequences.[36]

Taxation presents a separate jurisdictional issue. Chapter 64N currently imposes an excise on retail sales of marijuana and marijuana products by licensed marijuana retailers. Hemp-derived cannabinoid products sold outside the statutory definitions and licensing structure applicable to marijuana are not automatically subject to that excise solely because they contain cannabinoids.[37] Massachusetts does not currently have a comprehensive hemp-derived cannabinoid excise-tax system equivalent to the marijuana excise. Any future framework that creates a distinct hemp-derived cannabinoid retail market would therefore require the Legislature to determine how such products should be taxed and how DOR should administer registration, reporting, collection, and enforcement.

Taken together, the current Massachusetts framework establishes defined roles for hemp cultivation and processing, regulated marijuana establishments, food regulation, alcoholic beverage licensing, taxation, and local public-health oversight, but does not establish a single statutory system governing the full lifecycle of hemp-derived cannabinoid consumer products. Agency guidance has addressed several points of interaction among these systems, but questions remain regarding product classification, downstream licensing, retail channels, taxation, testing, age restrictions, interstate products, and enforcement. Any future framework governing hemp-derived cannabinoid products would therefore require the Legislature to determine the appropriate tax treatment of those products, including whether to apply existing marijuana taxes or establish a separate tax structure, and to identify the registration, reporting, collection, and enforcement responsibilities of DOR. These issues form the basis for the regulatory models and policy options evaluated in Part II.

C. Hemp-Derived Cannabinoid Products

The hemp industry encompasses agricultural, industrial, and consumer markets extending well beyond cannabinoid production. Hemp is cultivated for fiber, grain, seed, floral material, and transplants used in products ranging from textiles and construction materials to food, cosmetics, and animal products. This report focuses on hemp-derived cannabinoid products intended for human or animal use, which represent only one segment of the broader hemp economy. USDA estimated the value of

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[36] Mass. Dep't of Pub. Health & Mass. Dep't of Agric. Res., *Joint Notice: Hemp Derived CBD and THC Not Allowed in Food and Beverages Manufactured or Sold in Massachusetts* (May 29, 2024); Mass. Alcoholic Beverages Control Comm'n, *Advisory Regarding Food and Beverages Containing Hemp Derived CBD and/or THC on Licensed Premises* (May 30, 2024).

[37] Mass. Gen. Laws ch. 64N, §§ 1–3; *see also* Mass. Gen. Laws ch. 94G, § 1.

domestic industrial hemp production at approximately $739 million in 2025, with floral hemp cultivated for cannabinoid extraction representing a significant component of production value.[38]

Since enactment of the 2018 Farm Bill, the hemp-derived cannabinoid marketplace has developed from one centered largely on CBD products into a diverse commercial sector encompassing numerous cannabinoids, formulations, product forms, manufacturers, and retail channels. Advances in extraction, refinement, chemical conversion, and product formulation have allowed manufacturers to develop products with substantially different cannabinoid compositions, concentrations, intended effects, and methods of administration.[39]

The market includes both non-intoxicating products marketed primarily for wellness and other consumer uses and products intended to produce intoxicating or psychoactive effects. Hemp-derived cannabinoid businesses also participate in interstate supply chains that may involve cultivation, extraction, ingredient manufacturing, formulation, packaging, wholesale distribution, retail sales, and direct-to-consumer commerce in multiple states. This structure differs from many state-regulated marijuana markets, where cultivation, manufacturing, distribution, and retail sales generally occur within the boundaries of the regulating state.[40] Unlike state-regulated marijuana markets, which operate under established licensing and compliance frameworks, the hemp-derived cannabinoid market is not subject to a uniform system of regulatory oversight across jurisdictions. State requirements vary considerably, and some jurisdictions lack comprehensive regulatory frameworks governing the manufacture, testing, distribution, and retail sale of finished hemp-derived cannabinoid products.

The interstate nature of this market also presents challenges for verifying product origin and compliance with applicable hemp production requirements. Although hemp production must occur under an authorized USDA, state, or Tribal program to qualify under the federal production framework, the origin of cannabinoid ingredients incorporated into finished consumer products may not always be readily verifiable. Consumers may therefore rely on product labeling or marketing representations when determining whether a product is hemp-derived, without access to documentation establishing its source or compliance with applicable requirements.

For purposes of understanding the current marketplace, products may generally be considered according to two characteristics: their intoxicating potential and the product form through which the cannabinoid is delivered. These distinctions are relevant because products marketed under similar names or in similar formats can differ substantially in cannabinoid content, serving size, ingredients, manufacturing process, onset and duration of effects, and intended use.

1. Non-Intoxicating Hemp-Derived Products

CBD remains the most widely recognized non-intoxicating hemp-derived cannabinoid. CBD is commercially available in oils, tinctures, capsules, gummies, beverages, topical creams and lotions, cosmetics, bath products, and products intended for companion animals. Other cannabinoids generally marketed as non-intoxicating, including cannabigerol (CBG) and cannabinol (CBN), also appear in commercial products, either individually or in combination with CBD.

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[38] U.S. Dep't of Agric., Nat'l Agric. Stat. Serv., National Hemp Report 1 (Apr. 16, 2026).
[39] Whitney Economics, *supra* note 11; Beau R. Whitney, *Hemp Derived Cannabinoids in the Lone Star State: An Economic Impact Analysis of the Hemp Cannabinoid Industry in Texas* 5–8 (Whitney Econ. Mar. 2025).
[40] Whitney, *supra* note 39, at 17–18.

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Product development within this segment has expanded beyond single-cannabinoid formulations. Manufacturers market products combining cannabinoids with terpenes, botanical ingredients, vitamins, and other ingredients and differentiate products based on formulation, delivery method, and intended consumer use.[41] Products are distributed through specialty hemp and wellness retailers, pharmacies, grocery and convenience stores, online sellers, and other consumer retail channels where permitted by applicable law.

Many CBD and other non-intoxicating cannabinoid products are marketed using wellness-oriented terminology, including references to relaxation, sleep, recovery, or similar uses. Under the Federal Food Drug and Cosmetic Aact many of these claims are prohibited. FDA has cautioned that many health-related claims associated with CBD and other cannabis-derived products have not been evaluated or approved by the agency and has taken enforcement action against companies marketing cannabinoid products with unapproved therapeutic claims.[42] This distinction between consumer marketing and established therapeutic approval is relevant to understanding the current marketplace but is separate from the question of whether a product qualifies as hemp under federal controlled-substance law.

2. Intoxicating Hemp-Derived Products

The market for intoxicating hemp-derived cannabinoid products has expanded significantly and includes products containing hemp-derived delta-9 THC, delta-8 THC, delta-10 THC, hexahydrocannabinol (HHC), tetrahydrocannabiphorol (THCP), tetrahydrocannabihexol (THCH), and other cannabinoids marketed as capable of producing intoxicating effects.[43]

Hemp-derived delta-9 THC has become particularly prominent in finished consumer products. Under the federal framework established by the 2018 Farm Bill, the legal definition of hemp was based on a delta-9 THC concentration of not more than 0.3 percent on a dry-weight basis. Manufacturers consequently developed finished products capable of remaining within that concentration threshold while containing quantities of delta-9 THC sufficient to produce intoxicating effects when consumed. This has been particularly relevant for products such as beverages and edibles, where the weight of the finished product can permit measurable quantities of THC while remaining within the dry-weight percentage threshold.[44]

Delta-8 THC and certain other cannabinoids developed through conversion of hemp-derived CBD also became widely available following enactment of the 2018 Farm Bill. Because some cannabinoids occur naturally in hemp only in limited concentrations, commercial production may involve extraction, conversion, refinement, or other manufacturing processes. The legal treatment of these products has varied among jurisdictions and is directly affected by the federal amendments enacted in 2025 and

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[41] Whitney Economics, *supra* note 10; Whitney, *supra* note 39, at 5–8.

[42] U.S. Food & Drug Admin., FDA Regulation of Cannabis, *supra* note 14; U.S. Food & Drug Admin., FDA Issues Warning Letters, *supra* note 27.

[43] Whitney Economics, *2026 U.S. Hemp Cannabinoid Report* (Sept. 1, 2026); Matthew E. Rossheim et al., *Delta-8, Delta-10, HHC, THC-O, THCP, and THCV: What Should We Call These Products?*, 84 J. Stud. Alcohol & Drugs 357, 357–60 (2023); Ben S. Krotulski et al., *Investigation of the Intrinsic Cannabinoid Activity of Hemp-Derived and Semisynthetic Cannabinoids with β-Arrestin2 Recruitment Assays—and How This Matters for the Harm Potential of Seized Drugs*, 47 Arch. Toxicol. 2024 (2024).

[44] Lee Johnson et al., *Potency and Safety Analysis of Hemp Delta-9 Products: The Hemp vs. Cannabis Demarcation Problem*, 5 J. Cannabis Rsch. 29 (2023).

modified in 2026, as discussed in the preceding section.[45]

The intoxicating hemp-derived cannabinoid market is characterized by significant variation among products. Products may differ in cannabinoid concentration, serving size, recommended use, onset and duration of effects, combination of cannabinoids, ingredients, and manufacturing method. Products with similar branding or appearance therefore may not produce comparable consumer experiences. Additionally, the classification of a product as hemp-derived does not necessarily indicate that its finished cannabinoid content is limited to 0.3 percent THC or that its potency has been independently verified. Under the 2018 federal production framework, hemp compliance testing focused on agricultural material before harvest rather than establishing uniform testing requirements for finished cannabinoid consumer products. This variability also has implications for consumer understanding, particularly where products are sold outside regulatory systems that impose standardized potency, serving-size, testing, or labeling requirements.

3. Product Categories

Hemp-derived cannabinoid consumer products are available in many forms. Product form does not necessarily determine whether a product is intoxicating; many categories include both intoxicating and non-intoxicating formulations. Further, the intoxicating potential and other health effects of certain emerging or less extensively studied cannabinoids are not yet fully understood. Products marketed as non-intoxicating may still present other health or safety considerations depending on their composition, concentration, manufacturing process, or intended use.

i. Edibles**.** Edible products include gummies, chocolates, candies, baked goods, mints, chewing gum, capsules, soft gels, syrups, powders, and other ingestible formulations. Products vary substantially in cannabinoid concentration, serving size, ingredients, and intended effects. Edibles may contain a single cannabinoid or combinations of cannabinoids.

ii. Beverages**.** Hemp-derived cannabinoid beverages include sparkling waters, seltzers, sodas, teas, coffees, powdered drink mixes, energy drinks, cocktail alternatives, beverage enhancers, and other infused beverages. Products are available across a range of cannabinoid concentrations and serving sizes, including lower-dose formulations intended for individual consumption. Industry analysis has identified cannabinoid beverages as an expanding market segment supported by familiar consumer formats, product innovation, established beverage-production infrastructure, and expansion into retail channels outside traditional cannabis dispensaries.[46]

iii. Inhalable Products**.** Inhalable products include hemp flower, pre-rolls, vape cartridges, disposable vaporization devices, concentrates, and other inhalable formulations. Cannabinoids may occur naturally in the underlying plant material or may be incorporated

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[45] U.S. Food & Drug Admin., *5 Things to Know About Delta-8 Tetrahydrocannabinol – Delta-8 THC*, *supra* note 16; Nat'l Conf. of State Legislatures, *State Cannabis Policy Enactment Database*, *supra* note 16; Continuing Appropriations, Agriculture, Legislative Branch, Military Construction and Veterans Affairs, and Extensions Act, 2026, Pub. L. No. 119-37, div. B, § 781, 139 Stat. 495, 559–61 (2025); Continuing Appropriations and Extensions Act, 2027, Pub. L. No. 119-103, div. B, § 2019, 140 Stat. 987, 1003 (2026).

[46] Beau R. Whitney, *The U.S. THC Beverage Report* 2–8 (Whitney Econ. Sept. 2025).

during manufacturing through extracted, refined, or converted cannabinoid ingredients. Product composition and potency can vary substantially.

iv. Tinctures and Oils. Tinctures and oils are sold in both intoxicating and non-intoxicating formulations and are commonly intended for sublingual administration or incorporation into food or beverages. Products are available in a wide range of cannabinoid concentrations and formulations.

v. Topical Products. Topical products include lotions, creams, balms, salves, massage oils, cosmetics, and other products intended for external application. Many are marketed using CBD or other non-intoxicating cannabinoids, although product composition varies.

vi. Products Intended for Animals. The marketplace also includes oils, capsules, soft chews, treats, powders, topical products, and other cannabinoid products marketed for companion animals. These products are commonly marketed for animal wellness, mobility, or behavioral purposes. Federal requirements applicable to animal food, animal drugs, and products marketed with therapeutic claims differ from those applicable to products intended for human consumption.[47]

D. The Supply Chain and Current Market

The hemp-derived cannabinoid industry operates through a multi-stage supply chain extending from agricultural production to consumer retail. Depending on the product, the supply chain may include hemp cultivation, extraction, refinement or conversion of cannabinoids, ingredient manufacturing, product formulation, packaging, wholesale distribution, transportation and logistics, retail sale, and direct-to-consumer commerce.

Unlike many state-regulated marijuana markets, hemp-derived cannabinoid supply chains frequently cross state boundaries. Hemp may be cultivated in one jurisdiction, processed or extracted in another, incorporated into a finished product elsewhere, and distributed through regional or national wholesale networks before reaching consumers. This structure allows businesses to source biomass, cannabinoid ingredients, packaging, manufacturing services, and finished products from multiple jurisdictions.[48]

Retail availability similarly varies by jurisdiction. Depending on state law, hemp-derived cannabinoid products may be offered through specialty hemp retailers, smoke and vape shops, wellness stores, pharmacies, grocery and convenience stores, online marketplaces, food and beverage establishments, and other retail channels. In some jurisdictions, intoxicating products are limited to age-restricted or cannabis-regulated channels, while others permit specified products within broader retail markets.[49]

The breadth of this distribution network distinguishes the contemporary hemp-derived cannabinoid marketplace from both the traditional industrial-hemp sector and state-regulated marijuana

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[47] U.S. Food & Drug Admin., *FDA Regulation of Cannabis and Cannabis-Derived Products, Including Cannabidiol (CBD)*, Questions 24–26.

[48] Whitney, *supra* note 39, at 17–18.

[49] Nat'l Conf. of State Legislatures, State Cannabis Policy Enactment Database, *supra* note 16; Nat'l Conf. of State Legislatures, Regulating Hemp and Cannabis-Based Products, *supra* note 17.

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markets. It has also increased the importance of determining which entity bears responsibility for product testing, source verification, labeling, registration, recalls, age verification, and compliance when different stages of production and sale occur in different jurisdictions. These considerations are particularly relevant where regulatory responsibilities are divided among agricultural, public-health, cannabis, and other state agencies, or where products manufactured outside the Commonwealth enter the Massachusetts market.

The marketplace is also commercially dynamic. Manufacturers continue to introduce new cannabinoid combinations, formulations, product forms, delivery methods, and branding strategies. This innovation provides consumers with a broad range of products but also results in substantial variation in potency, composition, ingredients, serving size, and expected effects among products that may appear similar at retail.[50]

The federal changes enacted in 2025 and 2026 are likely to alter this marketplace by changing which cannabinoid products qualify as hemp under federal law. The extent of that effect will depend on product composition, manufacturing method, implementation of the new federal standards, and subsequent state action. Accordingly, the market described in this report should be understood as one in transition rather than a static commercial sector.

E. State Regulation of Ingestible Hemp Products and Optimal Procedures

States have responded to the growth of ingestible and intoxicating hemp-derived cannabinoid products through substantially different statutory and regulatory approaches. There is no single prevailing national framework. Instead, states have allocated responsibility among departments of agriculture, public-health and food-safety agencies, cannabis regulators, revenue agencies, and other entities, either individually or through interagency systems. NCSL similarly describes substantial variation in state approaches to hemp and cannabis-derived products, including differences in product definitions, permissible cannabinoid content, retail channels, age restrictions, and regulatory responsibility.[51]
For purposes of this study, the Commission reviewed these approaches to identify procedures that may be useful to Massachusetts independently of whether the Commonwealth adopts any particular state's overall framework. The review therefore focuses on regulatory tools and administrative practices rather than attempting to identify a single state model for wholesale adoption.

1. Recurring State Regulatory Approaches

State frameworks generally fall into several overlapping categories:

i. Agriculture-led systems, in which a department of agriculture retains substantial authority over hemp production and downstream hemp products;
ii. Food or public-health systems, which regulate ingestible products principally through food-safety or consumer-product laws;
iii. Cannabis-regulator systems, which place specified intoxicating hemp-derived products within the existing regulated cannabis market;

[50] Whitney, *supra* note 39, at 5–8.
[51] Nat'l Conf. of State Legislatures, State Cannabis Policy Enactment Database, *supra* note 16; Nat'l Conf. of State Legislatures, Regulating Hemp and Cannabis-Based Products, *supra* note 17.

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iv. Hybrid systems, which divide responsibility among agriculture, health, cannabis, revenue, or other agencies;
v. Restricted retail systems, which limit specified products to age-controlled or specially licensed establishments;
vi. General retail systems with enhanced safeguards, which permit broader retail availability while imposing product registration, testing, age, labeling, or other conditions; and
vii. Prohibition-based systems, which prohibit specified intoxicating, synthetic, semi-synthetic, or chemically converted cannabinoids.

States also differ in the characteristics used to determine regulatory treatment. Some focus on the source of the cannabinoid, while others rely on total THC, THC per serving or package, product form, manufacturing method, intoxicating effect, or combinations of these factors. These differences may result in products with similar cannabinoid content or intended effects being subject to different regulatory requirements depending on their source, classification, or jurisdiction of sale.

2. Recurring Regulatory Practices

Despite differences in overall structure, the state review identified several regulatory practices that recur across jurisdictions regulating ingestible or intoxicating hemp-derived cannabinoid products. These include:

- product, manufacturer, or retailer registration;
- testing for cannabinoid potency and contaminants;
- THC or other cannabinoid limits by serving or package;
- ingredient and additive restrictions;
- packaging and labeling standards;
- minimum purchase ages and identification requirements;
- online age and identity verification;
- restrictions on product forms or manufacturing methods;
- recordkeeping and traceability requirements;
- inspection and product-sampling authority;
- embargo and recall procedures;
- administrative penalties or license suspension;
- controls on interstate or out-of-state products; and
- coordination among state and local enforcement entities.

These measures can operate under different agency structures and therefore may be evaluated independently from the broader question of which entity should regulate the market. Their implementation may also require coordination among agencies responsible for different stages of the supply chain, particularly where hemp cultivation remains under agricultural oversight while downstream cannabinoid manufacturing, distribution, and retail activities are regulated separately.

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3. Selected State Models

i. Michigan. Michigan illustrates an approach that uses the state's cannabis regulatory structure for specified intoxicating cannabinoid products while maintaining separate agricultural oversight of hemp cultivation. This framework demonstrates how a state can retain an agricultural hemp program while directing certain finished products into an established cannabis licensing and compliance system.[52]

ii. Minnesota. Minnesota illustrates a hybrid approach. Hemp cultivation remains within the agricultural framework, while state law separately regulates lower-potency hemp-derived consumer products and cannabis products. Minnesota's framework includes product and retail requirements as well as documentation provisions concerning hemp obtained from outside the state. The model is relevant to Massachusetts because cultivation oversight and downstream consumer-product regulation are not necessarily assigned to the same agency.[53]

iii. New York. New York developed a cannabinoid-hemp licensing system distinct from its adult-use cannabis licensing structure. The framework regulates cannabinoid-hemp processors and retailers and establishes requirements for hemp extracts and cannabinoid hemp products intended for human consumption. This approach demonstrates a separate downstream licensing structure rather than either unrestricted general retail or full integration into the adult-use cannabis system.[54]

iv. Connecticut. Connecticut uses product categories and THC-content thresholds to determine regulatory treatment and permissible retail channels. Its framework distinguishes among lower-THC hemp products, moderate-THC products, infused beverages, and products regulated within the cannabis system.[55] This approach illustrates a product-tier model in which regulatory requirements increase according to cannabinoid content or product classification.

v. New Jersey. States also continue to consider new approaches to cannabinoid-beverage retail. Legislation introduced in New Jersey in 2026 proposed permitting certain alcohol retailers to sell low-dose THC beverages manufactured within the state's regulated cannabis system, subject to specified conditions.[56]

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[52] Mich. Comp. Laws §§ 333.27953, 333.27958; Mich. Cannabis Regul. Agency, *All THC Products Derived From the Cannabis Plant to Fall Under MRA Regulation Effective October 11, 2021* (Oct. 7, 2021); Mich. Dep't of Agric. & Rural Dev., *Industrial Hemp.*

[53] Minn. Stat. ch. 18K; Minn. Stat. §§ 342.45, 342.455. The current statutes address lower-potency hemp-edible manufacturing, wholesale activity, imports, testing, labeling, and source requirements.

[54] N.Y. Cannabis Law art. 5, §§ 92–105. *See, e.g.*, N.Y. Cannabis Law § 92 (cannabinoid hemp processor license), § 93 (cannabinoid hemp retailer license).

[55] Conn. Gen. Stat. §§ 21a-425, 21a-425a, 21a-426; *see also* Conn. Gen. Stat. § 21a-240. Connecticut separately regulates infused beverages and moderate-THC hemp products.

[56] S. 4452, 222d Leg., 1st Ann. Sess. §§ 1–4 (N.J. 2026) (as introduced June 15, 2026) (proposing to authorize plenary retail distribution licensees to sell qualifying low-dose THC beverages subject to product-source, age-verification, sales, and enforcement requirements).

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4. Procedures Relevant to Massachusetts

The state review suggests that several procedures can be considered independently of the broader regulatory model ultimately selected by the Legislature. These include clear statutory product classifications; designation of a responsible agency for each stage of the supply chain; product registration or traceability sufficient to support recalls; standardized potency and contaminant testing; enforceable packaging and labeling requirements; age verification for intoxicating products; controls for online sales and delivery; explicit authority for inspection, embargo, recall, suspension, and civil penalties; and mechanisms for state and local coordination.

For purposes of this report, an "optimal" procedure does not necessarily mean that the practice of any one state should be replicated in Massachusetts. Rather, procedures are evaluated based on their ability to address the regulatory issue identified while remaining administratively workable within Massachusetts' existing statutory and agency structure. Consideration of these procedures should also distinguish existing agency authority from proposed new responsibilities and account for the statutory authority, staffing, training, and funding necessary for implementation. Part II incorporates these recurring practices into the regulatory models and policy options presented for legislative consideration.

Part II: Recommendations

A. Regulatory Models and Policy Options for Legislative Consideration

The Commission presents four regulatory models for legislative consideration. The models are not mutually exclusive in every respect and are intended to illustrate different ways the Commonwealth could allocate regulatory responsibility, establish permissible retail channels, and regulate products according to cannabinoid content, intoxicating potential, product form, or manufacturing method.

Across the regulatory models, relevant consumer protection considerations include licensing and registration; processing and manufacturing standards; age verification; product form, dosage, and cannabinoid content requirements; packaging and labeling; advertising restrictions; and education, compliance, and enforcement programs. The application of these measures would depend on the products authorized for sale, the retail channels permitted, and the agencies designated to administer and enforce the requirements.

The Legislature may also consider the potential racial, economic, and health equity implications of each model, including effects on equitable licensing opportunities, small-business participation, business ownership, and enforcement practices. Relevant considerations include the history of disparities in cannabis enforcement, potential barriers to market participation, opportunities for technical assistance, and mechanisms for monitoring disparate impacts. Engagement with historically impacted communities and affected businesses may further inform the development and implementation of any regulatory framework.

The Commission does not identify one model as a preferred comprehensive framework. Each model should instead be considered together with the cross-cutting licensing, testing, age, retail, taxation, enforcement, and public-health considerations discussed below.

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Model 1: Restricted Age-Controlled Retail System

Under a restricted age-controlled model, all intoxicating hemp-derived cannabinoid products intended for ingestion or inhalation would be limited to retail sales through Commission-licensed Marijuana Retailers to individuals 21 years of age or older. This model would use the Commission's existing marijuana licensing infrastructure, with licensed Product Manufacturers serving as the point of entry for hemp-derived ingredients or finished products obtained from authorized sources. Qualifying products would be subject to testing, tracking, packaging, labeling, and retail requirements established by the Commission.

MDAR would retain responsibility for hemp cultivation, while downstream cannabinoid processing, manufacturing, and retail activities could be regulated by the Commission under a unified framework, subject to legislative authorization. This would allow the agency responsible for retail oversight to also establish and enforce manufacturing and finished-product standards. Under this structure, the Commission would be responsible for licensing, establishing and overseeing finished-product testing requirements, inspections, and enforcement within the regulated cannabinoid system. Product standards would need to address applicable potency and contaminant testing, including residual solvents, heavy metals, and manufacturing byproducts.

The Legislature would need to determine whether any non-intoxicating hemp-derived products would also be required to enter the restricted system, whether separate hemp-specific standards would be necessary, and whether existing Commission license types and systems could accommodate a new product category.

This model could make use of existing age-controlled licensing and compliance infrastructure, tax structures, and procedures governing transfers between MDAR licensees and Commission licensees, subject to any necessary modifications. The use of a single regulatory system for specified cannabinoid products could also promote greater consistency in manufacturing, testing, and retail requirements. However, this approach could create transition and market-access challenges for existing hemp manufacturers and retailers that do not currently participate in the Commission's licensed marijuana system. Additional considerations include potential effects on competition and equitable market participation, and the statutory authority, staffing, training and funding necessary for implementation.

Model 2: Risk-Tiered Product and Retail System

Under a risk-tiered model, regulatory requirements and permissible retail channels would vary according to characteristics such as intoxicating potential, cannabinoid composition, dose, product form, or manufacturing method. Non-intoxicating or lower-risk products could remain available through broader retail channels subject to baseline manufacturing, testing, and labeling requirements, while intoxicating ingestible or inhalable products could be subject to enhanced requirements and more limited age-controlled retail channels. Depending on the product classification, authorized retail channels could include general retail establishments, specialty hemp retailers, or Commission-licensed Marijuana Retailers, subject to the licensing, registration, and consumer protection requirements established for each product category.

MDAR would retain responsibility for hemp cultivation. Subject to legislative authorization, downstream authority could be allocated among MDAR, DPH, the Commission, or another designated agency based on product classification. Any such allocation should distinguish existing agency

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responsibilities from new regulatory functions and account for the statutory authority, staffing, training and funding necessary for implementation. In particular, assigning new cannabinoid-specific product registration, testing, retail oversight, or age-compliance responsibilities to DPH or another agency would require a clear legislative designation of authority, defined responsibilities, implementation capacity, and dedicated funding. Existing food-safety authority should not be presumed to encompass these additional functions.

This approach would allow regulatory requirements to vary according to the characteristics of the product rather than treating all hemp-derived cannabinoid products identically.

Potential advantages include the ability to tailor requirements to different product categories and preserve broader access to products assigned to lower regulatory tiers. Implementation considerations include the need for clear statutory definitions, objective thresholds between product tiers, procedures for emerging cannabinoids, and coordination among agencies where regulatory responsibility is divided. The use of multiple product classifications and retail channels could also create consumer confusion regarding product legality, potency, and applicable safeguards. Additional considerations include the administrative complexity of coordinating regulatory responsibilities across agencies, ensuring consistent enforcement, and addressing potential differences in market access among product categories and businesses.

Model 3: General Retail with Enhanced Safeguards

Under a general-retail model, specified hemp-derived cannabinoid products could remain available outside the Commission's licensed marijuana system if products and retailers satisfy statutory or regulatory safeguards. These could include retailer registration, product registration, minimum purchase ages for intoxicating products, mandatory testing, standardized packaging and labeling, online age verification, compliance checks, and inspection authority. Depending on the product category and applicable restrictions, authorized retail channels could include specialty hemp retailers, convenience stores, and other general retail establishments, subject to the requirements established for each product and retailer.

The Legislature could apply different retail restrictions based on product category. For example, higher-dose, intoxicating, inhalable, or chemically converted products could be limited to narrower retail channels while specified lower-dose or non-intoxicating products remain available through broader retail channels, convenience stores, and online marketplaces. The Legislature would also need to designate the agency or agencies responsible for product and retailer registration, testing and potency verification requirements, retail inspections, age-compliance checks, and enforcement. Any responsibilities assigned to DPH or local boards of health would need to be distinguished from existing retail-food permitting and inspection functions, including those established under 105 CMR 590. Existing food-safety oversight should not be presumed to encompass cannabinoid-specific registration, potency verification, or age-compliance requirements.

This approach would have similar regulations and safeguards to cannabis regulation and could result in direct competition with marijuana retailers. Potential advantages include preserving access to broader retail channels and allowing existing businesses to participate in a regulated hemp-derived cannabinoid market, subject to applicable requirements. However, this approach would also require the Commonwealth to establish or expand a regulatory system capable of overseeing a substantially larger

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number and variety of retailers than are currently regulated through the Commission's marijuana licensing structure or MDAR's hemp registration. Additional considerations include establishing effective youth-access protections, including in-person and online age verification and compliance checks, as well as ensuring adequate testing capacity and consistent enforcement across retail settings. Implementation would require clear assignment of regulatory and enforcement responsibilities, including any necessary statutory authority, staffing, training, information technology systems, and dedicated funding.

Model 4: Prohibition of Defined Intoxicating or Converted Products

Under this model, Massachusetts could prohibit the manufacture or retail sale of defined categories of intoxicating, chemically converted, synthetic, or semi-synthetic hemp-derived cannabinoid products while continuing to permit qualifying non-intoxicating hemp-derived products that comply with applicable federal and state requirements. State definitions could align with federal exclusions or establish separate Massachusetts classifications.

This approach could reduce the number of product categories requiring affirmative regulation but would require clear definitions that can accommodate changes in cannabinoid chemistry and product development. Enforcement of this approach would include distinguishing prohibited products from lawful hemp products and addressing online and interstate sales. The Legislature would also need to designate the agency or agencies responsible for identifying prohibited products, conducting inspections, and enforcing applicable restrictions, including any necessary coordination with other state agencies and local enforcement authorities.

Potential advantages include limiting the availability of specified product categories and reducing the regulatory requirements associated with their lawful manufacture and sale. However, implementation considerations include maintaining clear product classifications, monitoring emerging cannabinoids and manufacturing practices, and addressing products entering the Commonwealth through interstate commerce or online sales. Restrictions on particular products could also affect existing businesses, consumer access, and enforcement demands.

Some stakeholders disagree about the effects of prohibition-oriented approaches. The Drug Policy Alliance, for example, argues that prohibiting currently available hemp-derived THC products without establishing a replacement regulatory framework may shift some consumers toward illicit or less regulated markets and instead, advocates product testing, labeling, age restrictions, and manufacturing standards.[57] These views are presented as a stakeholder perspective rather than as a finding of the Commission.

Restrictions on defined intoxicating, synthetic, or chemically converted cannabinoid products could also be incorporated into one or more of the preceding regulatory models rather than established as a separate comprehensive framework.

[57] Drug Pol'y All., *supra* note 21.

B. Licensing Considerations

The appropriate licensing or registration structure depends on the broader regulatory model selected. Options include maintaining MDAR licensing for cultivation and qualifying hemp processing while creating separate downstream retailer or product registration; consolidating downstream cannabinoid processing, manufacturing, and retail licensing under the Commission while retaining MDAR's hemp cultivation responsibilities; or creating a distinct hemp-derived cannabinoid license administered by a designated agency.

A comprehensive framework should identify which activities require authorization and distinguish between business licensing and product registration. Entities potentially subject to authorization include manufacturers, processors, wholesalers, distributors, retailers, online sellers, and delivery operators. Any new cannabinoid-specific licensing or registration responsibilities assigned to DPH, local boards of health, or another designated agency should be expressly authorized by statute and distinguished from existing food-safety permitting and regulatory functions. Implementation would also require consideration of the staffing, training, administrative capacity, and funding necessary to administer these responsibilities.

Licensing provisions may also address:

- application and renewal requirements;
- fees;
- ownership and control;
- responsible persons;
- recordkeeping;
- inspection authority;
- information sharing among agencies;
- suspension and revocation;
- product registration;
- requirements applicable to online sellers; and
- requirements for products or ingredients originating outside Massachusetts.

If Massachusetts permits out-of-state hemp or cannabinoid inputs, one option is to impose source-verification requirements on the Massachusetts licensee or registrant receiving the material rather than attempting to license an out-of-state cultivator. Documentation could include evidence that the source participates in a lawful state, Tribal, or federal hemp program, certificates of analysis, manufacturing records, and other information necessary to establish product compliance. Any requirements applicable to out-of-state sources should also be evaluated for consistency with federal hemp transportation protections and applicable interstate commerce requirements.

The Legislature would also need to determine whether existing hemp businesses should receive a transition period to obtain any newly required license or registration and whether existing lawful inventory may continue to be sold during implementation. In establishing any new licensing or registration framework, the Legislature may also consider measures to promote equitable participation, including accessible application processes, technical assistance for small businesses, and consideration of potential barriers for communities historically affected by cannabis enforcement.

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C. Testing Requirements and Product Standards

Testing requirements should distinguish between cultivation-stage hemp compliance and finished-product safety and composition. Finished consumer products raise additional considerations involving cannabinoid content, contaminants, ingredients, manufacturing processes, and label accuracy.[58] Testing requirements may therefore be appropriate for both intoxicating and non-intoxicating hemp-derived cannabinoid products, with applicable standards determined by product characteristics, intended use, and potential safety risks. Depending on product type, a finished-product testing framework could address:

- cannabinoid profile and potency;
- pesticides;
- heavy metals;
- microbiological contaminants;
- mycotoxins;
- residual solvents;
- conversion or synthesis byproducts;
- prohibited ingredients or additives;
- batch and sampling requirements;
- certificates of analysis;
- label accuracy;
- stability and shelf life; and
- retesting, embargo, recall, and destruction procedures.

For intoxicating ingestible or inhalable products, one option would be to use testing requirements comparable to those applicable to regulated marijuana products, with modifications reflecting differences in hemp-derived ingredients and manufacturing processes.[59] A risk-tiered system could apply different testing panels depending on product form or manufacturing method, including enhanced requirements for chemically converted cannabinoids. Non-intoxicating hemp-derived cannabinoid products could similarly be subject to applicable potency, contaminant, and finished-product testing requirements, recognizing that the absence of intoxicating effects does not necessarily eliminate potential product safety concerns.

Any testing framework should also identify laboratory qualifications, accreditation or certification requirements, sampling responsibility, and the agency authorized to enforce testing failures and product recalls. In considering these requirements, the Commonwealth may evaluate its existing laboratory testing infrastructure and regulatory frameworks, which support the oversight of agricultural commodities, food, marijuana, and other consumer products. MDAR administers testing requirements

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[58] Eric E. Kaczor et al., *Commercial Delta-8 THC Products: An Analysis of Content and Labeling*, 20 J. Med. Toxicol. 31, 31–38 (2024); Mohamed M. Radwan et al., *Isolation and Characterization of Impurities in Commercially Marketed Δ8-THC Products*, 86 J. Nat. Prods. 822, 822–29 (2023).

[59] 935 Mass. Code Regs. 500.160 (2026).

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associated with hemp production and compliance with applicable THC thresholds, as well as testing requirements for certain hemp-derived products within its existing regulatory authority. Separately, the Commission maintains testing requirements for regulated marijuana and marijuana products, which must be tested by Commission-licensed Independent Testing Laboratories in accordance with applicable regulatory standards. DPH also operates the Massachusetts State Public Health Laboratory, which provides biological, chemical, and environmental testing services in support of public-health activities. These existing laboratory systems may provide relevant experience and infrastructure for evaluating potential testing requirements for hemp-derived cannabinoid products. However, their respective capabilities, regulatory authority, testing capacity, and the statutory authority, staffing, training, and funding necessary to assume additional responsibilities would need to be assessed.

D. Retail Sales

Potential retail channels include specialty hemp retailers, Commission-licensed marijuana establishments, other age-restricted retailers, grocery and convenience stores, pharmacies, food and beverage establishments, online retailers, and delivery services. The appropriate retail channel would depend on the product classifications, age requirements, and safeguards adopted by the Legislature. Any regulatory framework would also need to designate the agency or agencies responsible for overseeing authorized retail sales, including licensing or registration, inspections, compliance monitoring, and enforcement.

Alcohol Retail

Massachusetts currently treats hemp-derived cannabinoid food and beverages and alcoholic beverage retail as separate regulatory systems. The 2024 DPH/MDAR joint notice and corresponding ABCC advisory state that hemp-derived CBD or THC foods and beverages may not be sold on licensed alcohol premises under the current framework.

Across the regulatory models considered, the Legislature may consider maintaining separate retail channels for intoxicating hemp-derived cannabinoid products and alcoholic beverages to address concerns involving combined-use, cross-promotion, consumer-understanding, and regulatory-jurisdiction concerns.[60]

If the Legislature elects not to maintain separate retail channels and alcoholic beverage licensees are authorized to participate, ABCC identified additional safeguards that should apply. ABCC identified the Commonwealth's existing three-tier alcoholic beverage system as a potential model and recommended controls addressing product registration, distribution, shipment, delivery, age verification, sales to intoxicated persons, and interagency information sharing.[61] This consultation feedback concerned hemp-derived cannabinoid beverages and should not be interpreted as applying automatically to other hemp-derived product categories.

Pending legislation in New Jersey provides an additional example of a potential alcohol-retail

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[60] Margaret F. Bedillion et al., *The Effects of Simultaneous Alcohol and Cannabis Use on Subjective Drug Effects: A Narrative Review Across Methodologies*, 48 Alcohol Clin. & Experimental Rsch. 988, 988–99 (2024).

[61] Alcoholic Beverages Control Comm'n, Written Comments to Cannabis Control Commission Regarding Section 64 Hemp-Derived Cannabinoid Study (Sept. 2026) (on file with Commission).

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model. New Jersey Senate Bill 4452, introduced in June 2026, would authorize holders of plenary retail distribution licenses to sell low-dose THC beverages manufactured by licensed cannabis manufacturers.[62] The bill would limit qualifying beverages to less than 10 milligrams of THC per container, unless a higher amount is authorized by the New Jersey Cannabis Regulatory Commission, and would require sales to persons 21 years of age or older. The proposal also includes restrictions on vending-machine sales, storage and display requirements, point-of-sale age verification, a 24-container transaction limit, application of cannabis sales taxation, and regulatory authority shared between the Division of Alcoholic Beverage Control and the Cannabis Regulatory Commission. As introduced, the proposal illustrates an approach in which alcohol retailers could participate in cannabinoid-beverage sales while product manufacturing and certain regulatory controls remain within the state-regulated cannabis system.

The ABCC also recommended consideration of shipment and transportation requirements modeled on existing alcoholic beverage law.[63] Under G.L. c. 138, § 18, Massachusetts restricts shipment of alcoholic beverages into the Commonwealth outside statutorily authorized channels, while G.L. c. 138, § 22 establishes transportation-permit requirements for certain licensed transportation and delivery of alcoholic beverages.[64] If the Legislature adopts an alcohol-licensee or three-tier approach for hemp-derived cannabinoid beverages, it could determine whether comparable controls should apply to importation, wholesale distribution, transportation, and delivery.

Online Sales

Online and interstate sales present separate enforcement considerations because sellers may operate outside Massachusetts while selling directly to consumers within the Commonwealth. Regulatory options include:

- seller registration;
- product registration;
- third-party age and identity verification;
- retention of transaction records;
- restrictions on shipment of prohibited products;
- requirements that products sold into Massachusetts satisfy Massachusetts testing and labeling standards; and
- enforcement authority applicable to persons selling into the Commonwealth without a required authorization.

Any framework permitting online sales or direct-to-consumer delivery would also need to identify the agency responsible for oversight and enforcement, including verification of compliance with applicable product standards, age restrictions, and delivery requirements.

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[62] S. 4452, supra note 56, §§ 2–4.
[63] Alcoholic Beverages Control Comm'n, *supra* note 61.
[64] Mass. Gen. Laws ch. 138, §§ 18, 22.

E. Age Requirements and Youth-Access Safeguards

For intoxicating hemp-derived cannabinoid products, the Legislature may consider a minimum purchase age of 21, consistent with the Commonwealth's adult-use marijuana framework and age limits used in several state approaches to intoxicating hemp products.[65] The Legislature may separately determine whether non-intoxicating products warrant age restrictions based on product form, cannabinoid content, or intended use.

Age safeguards may include:

- government-issued identification requirements for in-person sales;
- reliable age and identity verification for online transactions;
- age verification at delivery;
- retailer compliance checks;
- penalties for sales to underage persons;
- child-resistant packaging where appropriate;
- restrictions on packaging, branding, or product presentation that appeals particularly to children; and
- limitations on advertising directed toward minors.

In establishing age-verification requirements, the Legislature may consider existing identification standards under Massachusetts law, including G.L. c. 138, § 34B, which addresses proof of age in connection with alcoholic beverage sales.[66] Requirements should also account for the range of acceptable identification documents and potential barriers for individuals who may have difficulty obtaining government-issued identification, while maintaining effective safeguards against underage access.

These safeguards could apply across authorized retail channels and product categories, subject to any distinctions established by the Legislature based on intoxicating potential, product form, or intended use. Implementation would require clearly defined responsibilities for age verification, compliance monitoring, and enforcement, including for online sales and delivery.

If alcoholic beverage licensees are authorized to sell hemp-derived cannabinoid beverages, ABCC recommended that legislation expressly prohibit sales or delivery to persons under 21.[67] ABCC also noted that employee-age requirements should be addressed separately. Existing Massachusetts alcoholic beverage law permits individuals 18 years of age or older to directly handle or sell alcoholic beverages in the course of employment, notwithstanding the 21-year minimum purchase age.[68]

ABCC further recommended an express restriction on sale or delivery of hemp-derived cannabinoid beverages to intoxicated persons if alcohol licensees are authorized to participate in that market.[69] Chapter 138 separately prohibits sale or delivery of alcoholic beverages to intoxicated persons.[70] The Legislature would therefore need to determine whether cannabinoid-specific legislation should

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[65] Alyssa F. Harlow et al., *Adolescent Δ8-THC and Marijuana Use in the US,* 331 JAMA 861, 861–65 (2024).
[66] *See* Mass. Gen. Laws ch. 138, § 34B.
[67] Alcoholic Beverages Control Comm'n, *supra* note 61.
[68] Mass. Gen. Laws ch. 138, § 34.
[69] Alcoholic Beverages Control Comm'n, *supra* note 61.
[70] Mass. Gen. Laws ch. 138, § 69.

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incorporate comparable restrictions and whether employee-age standards should mirror or differ from existing alcohol rules.

F. Taxation and Revenue

The Legislature may consider several approaches to taxation of hemp-derived cannabinoid products. Options include application of the general sales tax alone, a separate percentage-of-price excise for specified products, a potency-based tax, or product-specific taxation. These approaches generally contemplate taxation at the retail level. Alternatively, the Legislature could consider wholesale excise taxes imposed earlier in the distribution process, including a tax assessed per gallon on qualifying hemp-derived cannabinoid beverages however it would be limiting and might not encompass all forms of final-products.

Each retail level tax structure presents different administrative considerations. A percentage-of-price excise is comparatively straightforward to calculate but does not necessarily correspond to cannabinoid concentration or intoxicating potential. A potency-based tax would more directly incorporate cannabinoid content but would require standardized testing, clear measurement rules, and procedures for products containing multiple cannabinoids. Implementation would also require clear parameters identifying the agency or other authorized entity responsible for determining product potency and establishing that determination before the product is offered for sale. Without an independent and standardized process for determining potency in advance, DOR would face challenges identifying and applying the appropriate excise tax rate.

Product-specific tax rates could distinguish between beverages, edibles, inhalables, or other categories but would increase classification complexity. Such an approach would similarly require clear statutory or regulatory product definitions and advance classification by a designated agency to allow DOR to determine and administer the applicable tax rate.

Wholesale excise taxes would present additional considerations regarding the point of taxation, the entities responsible for collection and remittance, and the measurement standards applicable to different product categories.

Massachusetts' existing marijuana excise tax is established under G.L. c. 64N and applies by reference to marijuana, marijuana products, marijuana establishments, and marijuana retailers as defined in G.L. c. 94G.[71] If hemp-derived cannabinoid products are routed through the Commission's existing licensed marijuana system as described in Model 1, the Legislature could consider amending G.L. c. 64N to expressly address the tax treatment of those products. If products remain in a separate retail system, DOR would require statutory direction concerning registration, collection, filing, enforcement, and treatment of online and interstate sellers.

Fiscal analysis should consider both potential tax and fee revenue and the administrative costs associated with licensing, product registration, laboratory oversight, inspections, compliance checks, information technology, enforcement, and interagency coordination. The Legislature may also consider the public-health implications of different taxation approaches, including whether potency-based taxation could discourage higher-potency consumption while limiting the tax burden on lower-potency

[71] Mass. Gen. Laws ch. 64N, §§ 1–3; *see also* Mass. Gen. Laws ch. 94G, § 1.

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or non-intoxicating products. Any such approach would need to account for administrative feasibility and potential effects on consumer behavior. Additionally, the Legislature could consider dedicating a portion of the revenue generated to substance-use prevention, public education, treatment, and other related public-health initiatives.

G. Enforcement and Compliance

An effective regulatory framework should clearly identify the entity responsible for each enforcement function. Depending on the model adopted, those functions may include:

- inspections;
- product sampling;
- testing enforcement;
- administrative penalties;
- license or registration suspension or revocation;
- embargo;
- recall;
- seizure where authorized;
- online-sales enforcement;
- enforcement against unlicensed sellers;
- compliance checks;
- interstate-product enforcement; and
- state and local referrals.

The framework should also define the role of local boards of health and other municipal authorities and establish procedures for coordination among MDAR, DPH, the Commission, DOR, ABCC, and local enforcement entities. Such coordination may include procedures for information sharing, referrals, product identification, and determining the appropriate agency response when potentially unlawful hemp-derived cannabinoid products are identified. These procedures should distinguish existing enforcement authority from any additional powers or responsibilities established under a new regulatory framework.

If DPH or local boards of health are assigned additional enforcement responsibilities under any of the four regulatory models, the Legislature should clearly define those responsibilities and provide appropriate statutory authority, training, and dedicated resources to support implementation. The interaction between new cannabinoid-specific requirements and existing food regulation, including 105 CMR 590, would also need to be evaluated. Existing food-safety inspection and permitting responsibilities should not be presumed to encompass cannabinoid-specific product registration, potency verification, age-compliance checks, or other new enforcement functions.

If Commission licensure becomes mandatory for specified hemp-derived cannabinoid activity, the Legislature may need to clarify enforcement authority over persons conducting regulated activity without obtaining a license. Existing regulatory sanctions directed primarily at licensees may not provide the same mechanism for addressing an unlicensed actor. One legislative option is express civil enforcement authority against persons conducting activity for which Commission licensure or

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registration is required.

Interagency coordination would also be relevant where products are identified in retail establishments regulated by an agency that does not otherwise oversee the manufacture or registration of those products. The Legislature may consider establishing procedures for determining when potentially unlawful products should be referred to another agency, removed from sale, embargoed, or seized where authorized by law. Such procedures could identify the circumstances under which agencies should notify one another, share product information, or coordinate enforcement actions.

Depending on the regulatory framework adopted, interagency information sharing and coordination may be necessary to support consistent enforcement of hemp-derived cannabinoid requirements. Such coordination could include access to public lists of registered products, updates to product registrations, and notification of products identified as being sold in violation of applicable laws or regulations. Establishing clear information-sharing and referral procedures among relevant state and local agencies could allow each entity to enforce requirements within its respective jurisdiction while supporting a coordinated approach to identifying and addressing potentially unlawful hemp-derived cannabinoid products.

H. Additional Public-Health Safeguards

In addition to age requirements and testing standards, the Legislature may consider other public-health safeguards based on product form and intoxicating potential, including[72]:

- THC or cannabinoid limits per serving and package;
- standardized health or impairment warnings;
- pregnancy warnings;
- ingredient restrictions;
- adverse-event reporting;
- poison-control coordination;
- restrictions on products designed to resemble children's candy, snacks, or other youth-oriented products;
- consumer education;
- product recall requirements; and
- requirements concerning combined alcohol and cannabinoid marketing or consumption.

These measures need not apply identically to all hemp-derived products. A statutory framework could authorize different safeguards for intoxicating and non-intoxicating products or for ingestible, inhalable, topical, and other product categories. Any safeguards should be proportionate to the potential risks associated with the relevant product category, balancing consumer protection with the practical implications of implementation and avoiding requirements that could unintentionally function as a prohibition on otherwise lawful products.

If hemp-derived cannabinoid products are authorized for sale in establishments where alcoholic

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[72] Alice Burgess et al., *Delta-8 Tetrahydrocannabinol, Delta-10 Tetrahydrocannabinol, and Tetrahydrocannabinol-O Acetate Exposures Reported to America's Poison Centers*, 62 Clin. Toxicol. 256, 256–66 (2024); Fed. Trade Comm'n, *FTC and FDA Send Second Set of Cease-and-Desist Letters to Companies Selling Products Containing Delta-8 THC in Packaging Designed to Look Like Children's Snacks* (July 16, 2024).

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beverages are also available, additional considerations may arise regarding combined alcohol and cannabinoid use. Regulatory approaches could address product placement, advertising and cross-promotion, simultaneous sale, consumer warnings, staff training, and service to intoxicated persons without necessarily requiring the same rules for retail environments in which alcohol is not sold.

The Legislature would also need to identify the agency or agencies responsible for developing, implementing, and enforcing any additional public-health safeguards. Any new responsibilities should be distinguished from existing regulatory authority and supported by appropriate statutory authority, staffing, training, and dedicated funding.

Conclusion

The hemp-derived cannabinoid market developed rapidly following enactment of the 2018 Farm Bill, which removed qualifying hemp from federal controlled-substance treatment while leaving substantial authority over finished consumer products to existing federal and state regulatory systems. The resulting marketplace now encompasses non-intoxicating and intoxicating products, multiple product forms, interstate supply chains, and retail channels that differ substantially from traditional agricultural hemp and state-regulated marijuana markets.

Federal amendments enacted in 2025 and modified in 2026 substantially change the legal framework under which that market developed. Those changes are scheduled to take effect immediately before the statutory deadline for this report and may affect which products continue to qualify as hemp under federal law. At the same time, federal changes do not resolve every question concerning the regulation of hemp-derived cannabinoid products that remain lawful or the roles of state agencies in licensing, testing, retail sales, taxation, and enforcement.

Massachusetts enters this period with existing regulatory infrastructure distributed among several agencies. MDAR administers hemp cultivation and processing requirements within its jurisdiction; DPH regulates food and public-health matters; the Commission administers the regulated marijuana market; DOR administers state taxation; ABCC regulates alcoholic beverage licensees; and local boards of health and municipalities exercise responsibilities within their respective authority. Existing statutes and agency guidance documents address portions of the hemp-derived cannabinoid market but do not establish a single comprehensive system governing all finished cannabinoid products.

The four regulatory models presented in this report illustrate different ways the Legislature could address these issues while preserving MDAR's role in hemp cultivation and whether intoxicating hemp-derived cannabinoid products should be incorporated into the existing adult-use marijuana market and whether alcoholic beverage retailers are the appropriate location for the sale of these products. Regardless of the broader structure selected, the analysis identifies recurring policy questions involving product definitions, finished-product testing, youth access, retail and online sales, product traceability, recall authority, enforcement, interagency coordination, taxation, and the statutory authority, staffing, training and funding necessary to administer any new responsibilities.

The Commission's study is intended to provide the Legislature with a factual and comparative basis for evaluating those choices as federal law and the cannabinoid marketplace continue to evolve.

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Appendix A: Federal Hemp Timeline

Year	*Event*	*Significance*
1937	Marihuana Tax Act [36]	Congress enacted the Marihuana Tax Act of 1937, which imposed registration, transfer-tax, and recordkeeping requirements on persons producing, distributing, or transferring "marihuana." Although the Act did not establish a modern distinction between industrial hemp and marijuana, its requirements substantially restricted domestic cannabis cultivation and commerce.
1970	Controlled Substances Act [37]	Congress classified "marihuana" as a Schedule I controlled substance without distinguishing industrial hemp from marijuana, effectively prohibiting commercial hemp cultivation except under limited federal authorization.
2014	Agricultural Act of 2014 (2014 Farm Bill) [38]	Section 7606 of the Agricultural Act of 2014 authorized state departments of agriculture and institutions of higher education to grow or cultivate industrial hemp for research purposes where permitted by state law. The Act defined industrial hemp as Cannabis sativa L. and any part of the plant containing no more than 0.3 percent delta-9 tetrahydrocannabinol on a dry-weight basis. This marked the first significant federal recognition of hemp as distinct from marijuana.
2016	Federal Statement of Principles on Industrial Hemp [39]	The United States Department of Agriculture (USDA), in consultation with the Drug Enforcement Administration (DEA) and the Food and Drug Administration (FDA), issued a Statement of Principles explaining the federal government's interpretation of the industrial hemp pilot-program authority established by the 2014 Farm Bill. The agencies emphasized that the 2014 law authorized limited research and pilot-program activities rather than unrestricted commercial production.
2018	FDA Approval of Epidiolex [40]	The FDA approved *Epidiolex*, a purified cannabidiol prescription drug, for the treatment of seizures associated with Lennox-Gastaut syndrome and Dravet syndrome. Epidiolex became the first FDA-approved drug containing a purified substance derived from cannabis. Its approval also became relevant to whether CBD could lawfully be marketed in foods or dietary supplements under the Federal Food, Drug, and Cosmetic Act.
2018	Agriculture Improvement Act of 2018 (2018 Farm Bill) [41]	The Agriculture Improvement Act of 2018 removed qualifying hemp from the federal Controlled Substances Act definition of marijuana and established a national framework for commercial hemp production. The Act defined hemp as *Cannabis sativa L.* and its derivatives containing no more than 0.3 percent delta-9 THC on

		a dry-weight basis, authorized federal, state, and tribal production plans, and protected the interstate transportation of compliant hemp. The Act did not generally authorize the addition of CBD or other hemp-derived ingredients to food or dietary supplements. Products containing hemp-derived substances remained subject to the Federal Food, Drug, and Cosmetic Act and other applicable federal laws.[42]
2018	FDA statement regarding hemp-derived products.[43]	The FDA clarified that although hemp was no longer a controlled substance under certain circumstances, products containing cannabidiol (CBD) remained subject to the Federal Food, Drug, and Cosmetic Act and could not generally be marketed as dietary supplements or added to foods in interstate commerce absent FDA approval.
2019	USDA Interim Final Rule establishing the Domestic Hemp Production Program [44]	USDA established the initial federal regulatory framework governing hemp cultivation, licensing, sampling, testing, disposal of non-compliant plants, and state and tribal hemp plans.
2020	DEA Interim Final Rule Implementing the 2018 Farm Bill [45]	The DEA issued an interim final rule conforming its regulations to the 2018 Farm Bill. DEA stated that cannabis material exceeding 0.3 percent delta-9 THC on a dry-weight basis remained a controlled substance and that synthetically derived tetrahydrocannabinols remained Schedule I controlled substances. The rule contributed to continuing uncertainty regarding work-in-progress hemp material and cannabinoids produced through chemical conversion.
2021	USDA Final Rule [46]	USDA issued its final rule governing domestic hemp production. The final rule superseded the 2019 interim rule and finalized permanent regulations governing domestic hemp production, including updated testing requirements, negligent violation thresholds, and disposal procedures.
2021–Present	Expansion of State Regulation of Intoxicating Hemp Products [47]	Manufacturers increasingly marketed products containing delta-8 THC, delta-10 THC, THC-O, HHC, THC-P, and other cannabinoids produced through chemical conversion of hemp-derived cannabidiol. These products expanded rapidly because federal law regulates hemp primarily through delta-9 THC concentration rather than intoxicating potential. States increasingly adopted legislation or regulations addressing product testing, potency, age restrictions, packaging, labeling, retail channels, licensing, and enforcement. State approaches ranged from comprehensive regulation to restricting or prohibiting certain

		intoxicating or chemically converted cannabinoid products.
2022	Federal appellate court recognizes delta-8 THC products may fall within the federal definition of hemp [48]	The Ninth Circuit decision in *Ak Futures LLC v. Boyd Street Distro, LLC* concluded that hemp-derived delta-8 THC products derived from hemp fell within the plain language of the 2018 Farm Bill's definition of hemp, provided that its delta-9 THC concentration did not exceed 0.3 percent on a dry-weight basis and therefore were not controlled substances under the Controlled Substances Act. The court stated that the statute's definition did not turn on whether a hemp-derived product was intoxicating, increasing regulatory attention to intoxicating hemp-derived cannabinoids.
2022-Present	FDA Enforcement Involving Delta-8 THC [49]	In 2022, FDA issued its first warning letters concerning products containing delta-8 THC. FDA cited concerns involving unapproved drug claims, the addition of delta-8 THC to food, adverse-event reports, product variability, manufacturing processes, and products marketed in forms that may appeal to children. The FDA and the Federal Trade Commission subsequently pursued additional enforcement involving edible delta-8 THC products packaged to resemble familiar foods and candies.
2022–Present	States increasingly regulate intoxicating hemp-derived cannabinoids [50]	In response to public health, consumer safety, and youth access concerns, numerous states adopted legislation or regulations restricting, regulating, or prohibiting intoxicating hemp-derived cannabinoid products while others developed comprehensive regulatory systems.
2023–Present	FDA Determines That a New CBD Regulatory Pathway Is Needed [51]	FDA concluded that existing food and dietary-supplement authorities were not appropriate for regulating CBD products and stated that a new regulatory pathway was needed. FDA identified concerns involving dosage, duration of use, interactions with medications, exposure to children and pregnant individuals, and potential risks to animals. The agency stated that it was prepared to work with Congress to establish a framework providing appropriate access, safeguards, and regulatory oversight.
2023–2025	Extensions of 2018 Farm Bill Authorities [52]	Congress extended multiple authorities originally scheduled to expire under the 2018 Farm Bill while consideration of a successor Farm Bill continued. These extensions preserved much of the existing federal agricultural framework but did not resolve broader questions concerning intoxicating hemp-derived cannabinoids, finished consumer products, or FDA regulation of CBD.
2023–2026	Congress considers amendments to federal hemp policy [53]	Congress has continued debating revisions to the federal definition of hemp, regulation of intoxicating hemp-derived cannabinoids, and potential amendments through Farm Bill negotiations and other

		legislative proposals. At the time of this report, significant federal policy questions remain unresolved.
November 12, 2025	Federal Definition of Hemp Amended [54]	Congress enacted the Continuing Appropriations, Agriculture, Legislative Branch, Military Construction and Veterans Affairs, and Extensions Act, 2026. Section 781 amended the federal definition of hemp effective 365 days after enactment, or November 12, 2026. The amendment: • Changes the relevant concentration standard from delta-9 THC alone to total tetrahydrocannabinols, including tetrahydrocannabinolic acid; • Creates separate definitions for industrial hemp and hemp-derived cannabinoid products; • Excludes certain cannabinoids synthesized or manufactured outside the cannabis plant; • Excludes certain intermediate cannabinoid products containing cannabinoids with effects similar to THC; • Excludes final hemp-derived cannabinoid products containing more than 0.4 milligrams per container of total tetrahydrocannabinols and other cannabinoids having, or marketed as having, effects similar to THC; and • Directs FDA, in consultation with other relevant federal agencies, to publish lists identifying naturally occurring cannabinoids, naturally occurring THC-class cannabinoids, and other cannabinoids with similar effects.

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Appendix B: Massachusetts Hemp Timeline

The following timeline summarizes significant legislative, regulatory, and policy developments that have shaped the regulation of hemp within the Commonwealth. It is intended to provide historical context for the recommendations contained in this report and should not be interpreted as an exhaustive history of every statutory, regulatory, or administrative action related to hemp.

Year	***Event***	***Significance***
2017	Massachusetts Authorizes Industrial Hemp Research [55]	The Massachusetts Legislature enacted legislation authorizing the cultivation and processing of industrial hemp consistent with the Agricultural Act of 2014. The law directed the Massachusetts Department of Agricultural Resources (MDAR) to establish and administer an industrial hemp program, allowing licensed cultivation and processing for research purposes within the Commonwealth.
2018	MDAR Implements the Massachusetts Industrial Hemp Program [56]	Following enactment of the federal Agriculture Improvement Act of 2018, MDAR expanded implementation of the Commonwealth's hemp program by licensing hemp growers and processors and developing regulatory standards governing cultivation, processing, inspection, sampling, and compliance.
2019	Massachusetts Adopts Hemp Production Regulations [57]	MDAR promulgated 330 CMR 32.00, Hemp Production, establishing Massachusetts' regulatory framework governing hemp cultivation, licensing, inspections, testing, disposal of non-compliant crops, recordkeeping, and enforcement. The regulations aligned the Commonwealth's hemp program with the requirements of the Agriculture Improvement Act of 2018 and USDA's Domestic Hemp Production Program.
2020	USDA Approves the Massachusetts State Hemp Production Plan [58]	Pursuant to the Agriculture Improvement Act of 2018, USDA approved the Commonwealth's State Hemp Production Plan, authorizing Massachusetts to administer its own federally compliant hemp production program rather than operating under the federal default plan. USDA's approval confirmed that Massachusetts' regulatory framework governing licensing, inspections, sampling, testing, disposal of non-compliant plants, and enforcement satisfied federal requirements for state-administered hemp

		programs. This milestone marked the Commonwealth's transition from the research-oriented framework established under the 2014 Farm Bill to a permanent commercial hemp production program operating under federal oversight.
2021	MDAR Issues Policy Statement on the Sale of Hemp-Derived Products [59]	MDAR issued a policy statement clarifying which hemp-derived products may be lawfully sold within the Commonwealth and identifying products prohibited under Massachusetts law. The policy also explained the relationship between hemp regulation, food safety requirements, and existing state law governing consumer products.
2021	MDAR Issues Guidance Regarding the Sale of Hemp and Hemp-Derived Products to Marijuana Establishments [60]	MDAR issued guidance explaining the circumstances under which licensed hemp growers and processors may sell hemp and hemp-derived products to Cannabis Control Commission (Commission) licensees pursuant to Massachusetts law. The guidance established expectations for compliance by both hemp businesses and marijuana establishments and recognized the growing interaction between the Commonwealth's hemp and regulated marijuana markets.
2022	Cannabis Control Commission Issues Guidance on Hemp [61]	The Commission published guidance for its licensees regarding hemp and hemp-derived products, clarifying the interaction between Massachusetts marijuana laws and the Commonwealth's hemp program and providing compliance information for regulated businesses.
2022-2024	MDAR Updates Hemp Processor Policies [62]	MDAR has periodically revised its Hemp Processor Policy to reflect evolving federal law, industry practices, product manufacturing methods, and commercial processing activities. The policies established licensing expectations for commercial processors and clarified activities requiring licensure under Massachusetts law.
2024-2026	Continued Administration of the Massachusetts Hemp Program [63]	MDAR has continued administering the Commonwealth's hemp licensing program through annual licensing of growers and processors, inspections, regulatory testing, education, and enforcement activities under M.G.L. c. 128, §§ 116–123 and 330 CMR 32.00.

Appendix C: Legislative Mandate

The following statutory language directed the Cannabis Control Commission to conduct the study and prepare this report.

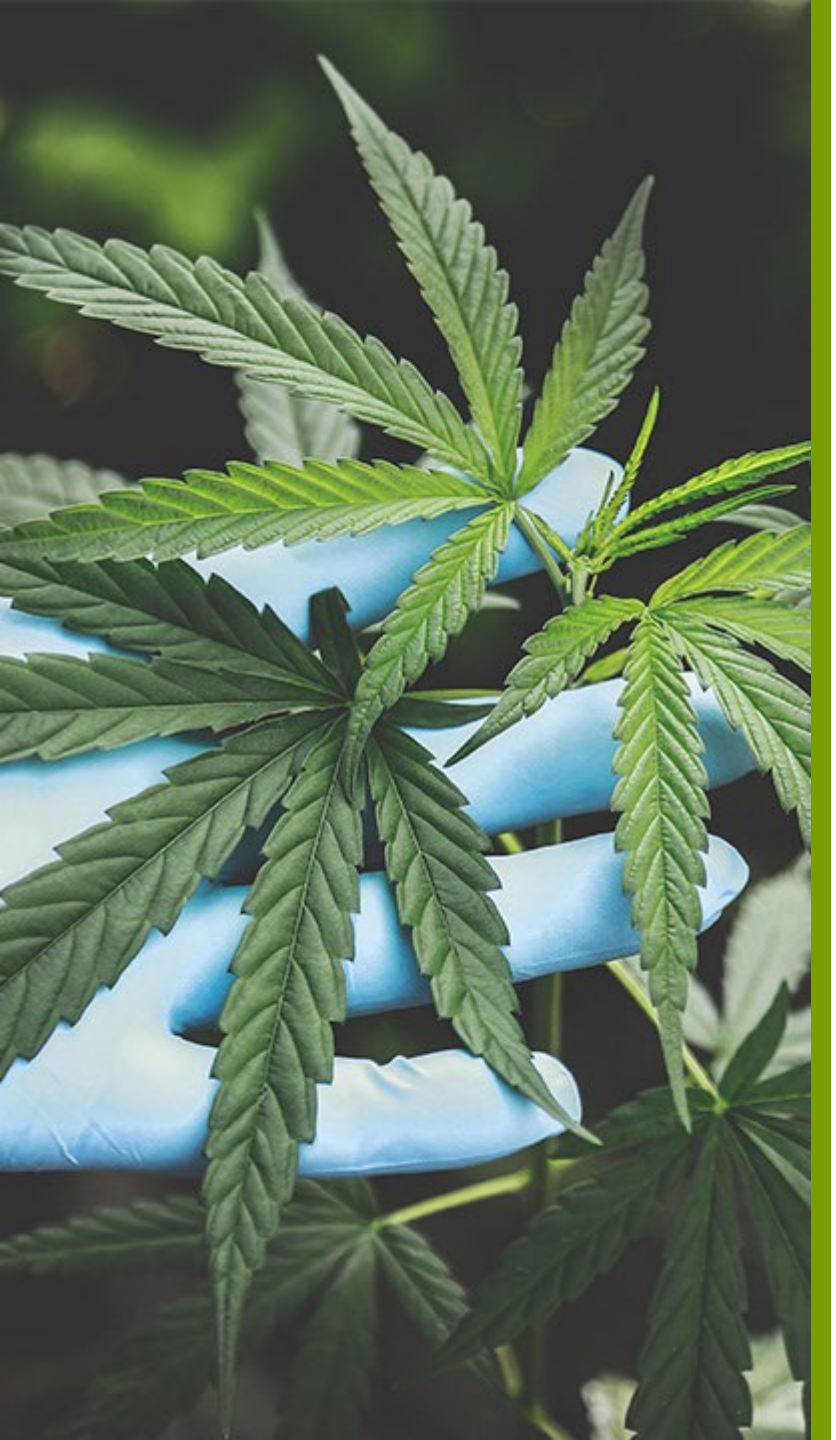
Section 64 of Chapter 65 of the Acts of 2026

SECTION 64. The cannabis control commission shall, in consultation with appropriate state agencies and departments including the department of public health, the department of agricultural resources, local boards of public health, the department of revenue and the alcoholic beverages control commission, conduct a study and develop recommendations regarding the effective regulation of the hemp-derived cannabinoid market, which shall include, but not be limited to: (i) ongoing federal law and other statutory or regulatory changes; (ii) licensing conditions; (iii) testing requirements and standards; (iv) appropriate age requirements and other safeguards against underage access; (v) regulations for potential retail sales and taxation; and (vi) optimal procedures in other states that have undertaken regulation of ingestible hemp products. Not later than December 15, 2026, the commission shall publish the results of the study on its website and submit a copy to the clerks of the senate and house of representatives and to the joint committee on cannabis policy.

DRAFT

Appendix D: Draft Cannabis Control Commission Regulations for Regulatory Model 1

DRAFT



Cannabis Control Commission
COMMONWEALTH OF MASSACHUSETTS

Cannabis Control Commission

Public Meeting

November 17, 2026 at 10:00 am

Hybrid via Microsoft Teams



Agenda

1. Call to Order
2. Commissioners' Comments and Updates
3. Staff Recommendations on Final Licenses
4. Commission Discussion and Votes
5. Executive Session
6. New Business Not Anticipated at the Time of Posting
7. Next Meeting Date
8. Adjournment

Cannabis Control Commission
COMMONWEALTH OF MASSACHUSETTS

Commissioner Comments and Updates

Cannabis Control Commission

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Staff Recommendations on Final Licenses

Staff Recommendations on Final Licenses

1. Responsible and Compliant Southwick LLC (#MR285245)

Cannabis Control Commission

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Commission Discussion and Votes

Commission Discussion and Votes

1. Chapter 65 Fall Regulatory Round Policy Discussion
2. Discussion on Drive Throughs at Marijuana Establishments
3. Discussion of Study and Recommendations Regarding the Effective Regulation of the Hemp-Derived Cannabinoid Market in Massachusetts



Cannabis Control Commission

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Discussion of Chapter 65 Fall Regulatory Round

Proposed Licensing Fees

Proposed Licensing Fees				
	Medical Use		Adult Use	
License Type	Application Fee	Annual License Fee	Application Fee	Annual License Fee
Fully Integrated Medical Marijuana Treatment Center	All applicable application fees for each activity included in the application	All applicable licensing fees for each authorized activity	N/A	N/A
Medical Marijuana Dispensary / Marijuana Retailer	$1,500	$10,000	$1,500	$10,000
Marijuana Cultivator	For FIMTC Fees Only:	For FIMTC Fees Only:		
Tier 1: up to 5,000 sq. ft.	$200 (I)/$100 (O)	$1,250 (I)/$625 (O)	$200 (I)/$100 (O)	$1,250 (I)/$625 (O)
Tier 2: 5,001 to 10,000 sq. ft.	$400 (I)/$200 (O)	$2,500 (I)/$1,250 (O)	$400 (I)/$200 (O)	$2,500 (I)/$1,250 (O)
Tier 3: 10,001 to 20,000 sq. ft.	$600 (I)/$300 (O)	$5,000 (I)/$2,500 (O)	$600 (I)/$300 (O)	$5,000 (I)/$2,500 (O)
Tier 4: 20,001 to 30,000 sq. ft.	$2,000 (I)/$1,500 (O)	$20,000 (I)/$10,000 (O)	$2,000 (I)/$1,500 (O)	$20,000 (I)/$10,000 (O)
Tier 5: 30,001 to 40,000 sq. ft.	$2,000 (I)/$1,500 (O)	$22,500 (I)/$11,250 (O)	$2,000 (I)/$1,500 (O)	$22,500 (I)/$11,250 (O)
Tier 6: 40,001 to 50,000 sq. ft.	$2,000 (I)/$1,500 (O)	$25,000 (I)/$12,500 (O)	$2,000 (I)/$1,500 (O)	$25,000 (I)/$12,500 (O)
Tier 7: 50,001 to 60,000 sq. ft.	$2,000 (I)/$1,500 (O)	$30,000 (I)/$15,000 (O)	$2,000 (I)/$1,500 (O)	$30,000 (I)/$15,000 (O)
Tier 8: 60,001 to 70,000 sq. ft.	$2,000 (I)/$1,500 (O)	$35,000 (I)/$17,500 (O)	$2,000 (I)/$1,500 (O)	$35,000 (I)/$17,500 (O)
Tier 9: 70,001 to 80,000 sq. ft.	$2,000 (I)/$1,500 (O)	$40,000 (I)/$20,000 (O)	$2,000 (I)/$1,500 (O)	$40,000 (I)/$20,000 (O)
Tier 10: 80,001 to 90,000 sq. ft.	$2,000 (I)/$1,500 (O)	$45,000 (I)/$22,500 (O)	$2,000 (I)/$1,500 (O)	$45,000 (I)/$22,500 (O)
Tier 11: 90,0001 to 100,000 sq. ft.	$2,000 (I)/$1,500 (O)	$50,000 (I)/$25,000 (O)	$2,000 (I)/$1,500 (O)	$50,000 (I)/$25,000 (O)
Marijuana Product Manufacturer	For FIMTC Fees Only: $1,500	For FIMTC Fees Only: $10,000	$1,500	$10,000

Proposed Other Fees

Proposed Other Fees (cost per License)		
	Medical Use	**Adult Use**
Change in Name Fee	$1,000	$1,000
Change in Location Fee	FIMTC: $10,000 MMD: $5,000	50% of applicable License Fee
Change in Building Structure Fee	$1,000	$1,000
Change in Ownership or Control Fee (involving at least one entity)	$5,000 per entity, per License	$5,000 per entity, per License
Change in Ownership or Control Fee (involving individuals)	$500 per person	$500 per person
Architectural Review Request Fee	$1,500	$1,500
Packaging and Labeling Preapproval Application Fee	$50 per product	$50 per product
MME Agent / ME & Lab Agent Registration Application Fee	$115	$115
MME Agent / ME & Lab Agent Registration Annual Fee	$115	$115
Registration of Caregiving Institutions Initial Registration	$500	N/A
Registration of Caregiving Institutions Three-Year Renewal Fee	$300	N/A
Registration of Institutional Caregivers Initial Registration	$50 per individual	N/A
Registration of Institutional Caregivers Three-Year Renewal Fee	$35 per individual	N/A
Change of Location Fee for Caregiving Institutions	$100	N/A

Adult-Use Concentrate Equivalencies and Licensing Fees

Equivalencies	Jurisdiction	Flower amount	Adult Use Fees	Medical Fees
5 Grams of Concentrate	Arizona	1 oz	Initial Application can't exceed $25,000 Renewal Application - $5,000	Initial dispensary application - $5,000 Renewal dispensary application - $1,000
	Vermont	1 oz	Application Fee (All Licenses) - $1,000 Cultivation - $750-$34,000 (Outdoor) ; $1,500-$75,000 (Indoor) Manufacturing $750-$15,000 Retail - $10,000 Testing - $1,500	Retail Application - $5,000 Medical-use Endorsement for AU Retail–$10,250
7 Grams of Concentrate	Washington	1 oz	Producer license - $250 application, $1,781 annual Processor license - $250 application, $1,781 annual Retailer License - $250 application, $1,781 annual	N/A
8 Grams of Concentrate	California	28.5g	Cultivation- $135 - $8,655 application, $1,205 - $77,905 license Processor- $1,040 application, $9370 license Manufacturing- $1,000 application, $2,000 - $75,000 license Retail- $1,000 application, $2,500 - $96,000 license	Same as AU
	Colorado	2 oz	Retail- $3,120-$8,470 license; $5,620-$11,240 2nd yr license; $2,400 annual Cultivation - $2,440 - $7,370 license; $4,940-$9,870 2nd yr license; $2,400-$9350 annual Manufacturer- $2,440 - $7,370 license; $4,940-$9,870 2nd yr license; $2,400 annual Testing - $2,100- $4,725 license; $3,150-$5,775 2nd yr license; $2,400 annual	Retail - $8.460 - $16,910 license; $2,420 annual Cultivation - $3.210 - $6,410 license; $2,420-$5,200 annual Product Manufacturer- $3.210 - $6,410 license; $2,420 annual Testing - $3.210 - $6,410; $2,420 annual
	Minnesota	2 oz	Tesitng - $5,000 application; $5,000 license; $10,000 annual Retailer- $2,500 application; $2,500 license; $5,000 annual Cultivator- $10,000 application; $20,000 license; $30,000 renewal Manufacturer: $10,000 application; $10,000 license; $20,000 annual	N/A

* Information as of November 2026

Adult-Use Concentrate Equivalencies and Licensing Fees

	Jurisdiction	Flower amount	Adult Use Fees	Medical Fees
10g	Illinois	60g	Retail- $60,000 Cultivation (early approval)- $100,000 Infuser- $5,000	Retail- $10,000
	Maine	2.5oz	Cultivation - $100 – 500 application; $500- $30,000 annual Manufacturing- $250 application; $2,500 annual Retail- $250 application; $2,500 annual Testing- $250 application; $1,0000 annual	Dispensary- $5,000 annual Manufacturer- $350
12g	Delaware	1 oz	$10,000 per licensed activity	$40,000 biennial per facility
	Maryland	1 oz	Grower - $50,000 Processor - $25,000 Dispensary - $25,000 On-site consumption - $10,000	Same as AU
15g	Michigan	2.5oz	All Applications - $3,000 Grower- $1,200 - $24,00 Processor - $24,000 Retailer - $15,000	All Applications - $3,000 Grower- $2,500- $15,000 Processor- $5,500
	Ohio	2.5oz	Cultivation - $20,000 - $200,000 annual Processor - $50,000 annual Testing Lab - $40,000 (biennial); Dispensary - $70,000 (biennial)	Same as AU
16g	Oregon	8oz	Producer - $1,000-$5,750 Processor - $4,750 Retailer - $4,750 Lab- $4,750	Grower- $200 Processor - $4,000 Dispensary - $4,000

* Information as of November 2026

Regulatory Policy Questions

Medical Fees

- Whether to adopt the proposed fee schedule for medical and adult use.

Refundable Fees

- Whether to explicitly state that all fees are non-refundable.
  [Please note: The Commissioners would still retain the authority to provide equitable relief to licensees in special circumstances]

Late Fees/Renewals [New Proposal from I&E]

- Whether to institute late fees for annual licensing fees and set a renewal window after expiration.

Equivalencies

- Whether to maintain the status quo for equivalencies (1oz flower : 5g concentrate) or adopt a new conversion/equivalency standard.

Cannabis Control Commission

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Discussion on Drive Throughs at Marijuana Establishments

Cannabis Control Commission

COMMONWEALTH OF MASSACHUSETTS

Discussion of Study and Recommendations Regarding the Effective Regulation of the Hemp-Derived Cannabinoid Market in Massachusetts

Section 64 of Chapter 65 of the Acts of 2026

The cannabis control commission shall, in consultation with appropriate state agencies and departments including the department of public health, the department of agricultural resources, local boards of public health, the department of revenue and the alcoholic beverages control commission, conduct a study and develop recommendations regarding the effective regulation of the hemp-derived cannabinoid market, which shall include, but not be limited to:

(i) ongoing federal law and other statutory or regulatory changes;

(ii) licensing conditions;

(iii) testing requirements and standards;

(iv) appropriate age requirements and other safeguards against underage access;

(v) regulations for potential retail sales and taxation; and

(vi) optimal procedures in other states that have undertaken regulation of ingestible hemp products.

Not later than December 15, 2026, the commission shall publish the results of the study on its website and submit a copy to the clerks of the senate and house of representatives and to the joint committee on cannabis policy.



Cannabis Control Commission

COMMONWEALTH OF MASSACHUSETTS

The Commission is in Executive Session

Cannabis Control Commission
COMMONWEALTH OF MASSACHUSETTS

Upcoming Meetings & Adjournment

Upcoming Meetings and Important Dates

Next Meeting Date
December 10, 2026 Public Meeting Hybrid via Teams 10:00 am

2027 Public Meetings*
January 14, 2027
February 2, 2027
February 11, 2027
February 25, 2027
March 4, 2027
March 11, 2027

**Public Meeting dates are tentative and subject to change*

Cannabis Control Commission

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The Commission is in recess until 12:45