



Council File 14-0366-S4

Vanessa May <may.vanessa.d@gmail.com>
To: Richard.Williams@lacity.org

Sat, Nov 18, 2017 at 3:02 PM

TO: LA City Council - Rules, Elections and Intergovernmental Relations Committee
FR: Vanessa D. May - Lake View Terrace, CA 91342 Resident
RE: Council File 14-0366-S4: CPC-2017-2260-CA; ENV-2017-2261-ND; ENV-2017-3361-SE
The Commercial Cannabis Location Restriction Ordinance

I have two major concerns, (1) If cannabis grows are to be allowed in A Zones; the "Sensitive Site" "800-foot radius" buffer zone requirement MUST apply to cannabis farming, greenhouse grows and plant nurseries in A1 and A2 Zones and (2) those wanting to engage in commercial cannabis growing and cultivation operations must go through Conditional Use Permitting processes and thorough CEQA evaluations.

1. The "Sensitive Site" "800-foot radius" buffer zone requirement MUST apply to cannabis farming, greenhouse grows and plant nurseries in A1 and A2 Zones

Please consider expanding the "Sensitive Site" "800-foot radius" buffer zone requirement to include cannabis farming, greenhouse grows and plant nurseries in A1 and A2 Zones.

As stated in the LA Department of City Planning Recommendation Report "many of the zones in which farming is permitted lie in close proximity to residential zones". It follows that many of these residential zones include homes with families where children and teenagers live. Consequently, many of these zones have "Sensitive Sites" that cater to children and teenagers.

The main purpose of the "Sensitive Site" designation and its attendant distancing requirement is to protect or minimize the deleterious effects on impressionable/vulnerable populations and communities from the negative impacts known to be associated with hazardous, age specified activity, and/or adult themed sexual commercial operations and/or the problems caused by the overconcentration, in certain areas, of these operations.

Studies and reports show that cannabis growing operations are, INDEED, hazardous and risky as they are more prone and susceptible to violent robberies and thefts because of the crop being grown and its street value when sold. Moreover, thieves have been known to steal cannabis plants to grow for their own personal use.

Resultantly, allowing cannabis grows, etc. within 800 feet of "Sensitive Sites" will endanger the visitors thereof and the residents in said communities. Cannabis plant thieves may also be tempted to commit other thefts/crimes while in the area and/or cause major disturbances while attempting or committing the crimes (alarms going off, security dogs barking or attacking, gun shots, shoot outs, police sirens, police helicopters, barricade situations, hostage situations, police pursuits, etc.).

Furthermore, area teenagers may be tempted to pilfer some cannabis plants from nearby grows, since they won't be able to legally purchase it. Let's not kid ourselves, we all know some teens love weed and will do just about anything to get it.

This is NOT hemp or cotton. This is NOT corn or tomatoes. Cannabis is a psychoactive drug and must be dealt with accordingly.

In order to protect families and their progeny from the hazards that come with growing commercial cannabis in large quantities, the "Sensitive Site" "800-foot radius" buffer zone distancing requirement needs to be

enforced in A1 and A2 Zones. This is a public safety and quality of life issue that must not be disregarded in favor of the “marketplace”.

2. Conditional Use Permitting Processes and thorough CEQA Evaluations are Needed

Because of the detrimental societal and environmental impacts that commercial cannabis grows cause, commercial cannabis growing and cultivation operations must go through a thorough Conditional Use Permitting process and a thorough CEQA evaluation.

Based on the likely attendant commercial cannabis growing and cultivation risky and hazardous situations discussed above, the rationale for a thorough Conditional Use Permitting process is clear. Communities will be detrimentally impacted by these growing operations and thus have a right to be publically heard and their concerns noted and considered.

The heavy duty fertilizers and pesticides used to promote rapid growth & high yield and the THC potency increasing, genetically modifying chemicals used in most commercial cannabis growing operations contain and/or create toxins that when released into the environment cause environmental degradation and harm. Therefore, those wishing to engage in such operations need to undergo a thorough CEQA evaluation.

Again, this is another public safety and quality of life issue that must not be disregarded in favor of the “marketplace”.

Respectfully submitted,

Vanessa D. May



Richard Williams <richard.williams@lacity.org>

Fwd: Fwd: Marijuanas-Impact-to-Communities-and-the-Environment_Updated04-8-17.pdf

Andrew Westall <andrew.westall@lacity.org>
To: Richard Williams <richard.williams@lacity.org>

Sat, Nov 18, 2017 at 8:32 PM

Please add to 14-0366-S4. Thanks!

----- Forwarded message -----

From: **Nancy Woodruff** <amazgrey@aol.com>

Date: Sat, Nov 18, 2017 at 2:09 PM

Subject: Fwd: Fwd: Marijuanas-Impact-to-Communities-and-the-Environment_Updated04-8-17.pdf

To: councilmember.krekorian@lacity.org, karo.torossian@lacity.org, MikeOGaraSVANC@aol.com, cindy@cmprintmail.com, andrew.westall@lacity.org, councilmember.englander@lacity.org, judi13@gmail.com

Please read the attached relating to Cannabis Cultivation experiences and why we should not allow it in the A zones.

Thanks you,

Nancy Woodruff, Foothill Trails District Neighborhood Council Land Use Chair

From: may.vanessa.d@gmail.com

To: amazgrey@aol.com, howard_sharon@earthlink.net

Cc: cat.packer@lacity.org, Humberto.Quintana@lacity.org

Sent: 11/18/2017 10:40:26 AM Pacific Standard Time

Subject: Fwd: Marijuanas-Impact-to-Communities-and-the-Environment_Updated04-8-17.pdf

The attached is FYI.

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Andrew Westall
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 **Marijuanas-Impact-to-Communities-and-the-Environment_Updated04-8-17.pdf**
480K

Marijuana’s Impact on Communities and the Environment:

WHAT THURSTON COUNTY SHOULD CONSIDER

Michelle Horkings-Brigham

Revised 4/8/2017

(Revisions made to size of Tier 1 (2,000 sq. ft.), vesting and cooperatives under “Future Recommendations,”
employment estimates under “Increased Traffic.”)

INTRODUCTION

Following the legalization of marijuana production and processing in Washington State through Initiative 502 (I-502) in 2012, government regulations should be expected to protect citizens from any harmful effects associated with this developing industry. In reviewing the literature, it is difficult to find scientific studies that analyze the social or environmental impacts of commercial marijuana operations zoned in rural residential or agricultural neighborhoods. Although there is evidence of public complaint regarding the negative effects to communities from large-scale *Cannabis* facilities, there is a lack of in-depth studies on those impacts. In investigating the information available, two questions are posed: What potential environmental impacts should be addressed when creating a final Ordinance that governs large-scale marijuana production and processing operations? What social concerns should be considered when drafting a final Ordinance to regulate marijuana production and processing operations in Thurston County?

This paper synthesizes existing research on the potentially harmful effects of commercial *Cannabis* cultivation to natural ecosystems and neighboring communities. Until November 10, 2015, zoning and regulations in Thurston County’s Interim Ordinances governing marijuana commercial operations in the County failed to protect rural residents from a myriad of issues that include: unsightly land conversion, deforestation, unpermitted grading and construction, toxic waste, unregulated marijuana cultivation, pollution (air, water, noise and light pollution), greenhouse gas emissions, water consumption, degraded road conditions, crime and neighborhood safety (Thurston County Washington, 2014-2016). This paper informs readers and government officials of arguments that oppose the zoning of commercial marijuana production and processing operations in rural residential and agricultural areas. As a result of these findings, recommendations are made that could provide greater environmental oversight and afford better protection to citizens, habitat, and property when determining a final Ordinance.

The information presented examines 1) community outcomes of earlier interim marijuana production and processing ordinances, 2) *Cannabis* cultivation methods, and 3) the related negative impacts (energy consumption, environmental degradation, and destruction of neighborhood character) that could threaten pristine areas of Thurston County with the inappropriate zoning of this industry.

THURSTON COUNTY'S INTERIM ORDINANCE

In 2012, the passage of I-502 legalized recreational and commercial marijuana production in Washington State. Individuals could now grow *Cannabis* at their own residence, including their backyard. Thurston County has since moved through nine Interim Ordinances regulating the production and processing of marijuana in the past four years (Thurston County Washington, 2017). The delay of a final Ordinance is an indication of the confusion and debate that has surrounded this developing business model since voters legalized the industry in 2012.

In 2013, the Washington State Liquor Control Board, later renamed The Washington State Liquor and Cannabis Board (WSLCB), held 13 public hearings, and met with over 6,000 state residents, in order to draft new regulations to govern the commercial production, processing and distribution of marijuana (Pardo, 2014 p. 729). Though a respectable number among the state's total population – approximately 6,900,000 in 2013 (Office of Financial Management, 2016 p. 19) – determining what percentage were *Cannabis* business enthusiasts that affected baseline policy to regulate this emerging industry, would be an interesting statistic in future studies researching the impacts to neighboring residents.

Applications to produce, process, and distribute marijuana were first accepted in Washington State in December, 2013 (Pardo, 2014 p. 729). Yet thorough investigation into the social and environmental repercussions to communities resulting from this cultural shift are challenging to locate. Without more extensive research, less than fully informed decisions regulating *Cannabis* production and processing made on behalf of residents and property owners in Thurston County may significantly impact quality of life, ecosystem functioning, and neighborhood character.

The peer-reviewed literature could be limited due to the continued classification of *Cannabis* as a Schedule I drug, which is defined as having a high potential for abuse by the US Drug Enforcement Administration (2017), and horticultural plant, not agricultural, by the Federal Government. These definitions led to a gray area in early Interim Ordinances' zoning of commercial marijuana operations in Thurston County. Federal definitions of marijuana as a horticultural plant prompted the Board of Thurston County Commissioners, defending the early zoning of large-scale *Cannabis* operations, to state in 2013 that marijuana production “resembles a type of agricultural use” (Chalem, 2016; Smith, 2015 p. 3; Board of Thurston County Commissioners, 2013). However, written comments and testimony received at public hearings by Thurston County officials over the past two years regarding the zoning of large-

scale marijuana facilities (Thurston County Washington, 2014-2016), has brought attention to the fact that mandated 8' high, chain-link fencing topped with multiple security cameras (WSLCB, 2017), hardly resembles typical agricultural practice.

Concerns surrounding commercial marijuana operations located in rural residential and agricultural areas, as described at Thurston County public hearings and through written correspondence (Thurston County Washington, 2014-2016), include the following:

- Loss of neighborhood character.
- Concerns about personal and family safety.
- Increased criminal activity.
- Large-scale land conversion such as deforestation and earth movement.
- Pest infestations.
- Unpermitted construction of facilities.
- Illegal marijuana production and processing.
- Loss of neighboring property value.
- Risks to children and pets.
- Water, soil, light, noise, and air pollution.
- Intolerable skunk-like odor.
- Overuse of pesticides, rodenticides, and fertilizers.
- Damage to wetland areas.
- Detrimental impacts to habitat, species, and ecosystems.
- Overconsumption of water and depleted aquifers.
- Degraded road conditions.
- Excessive noise from guard dogs, industrial fans, and generators.
- Storm and industrial wastewater runoff.
- Increased traffic.
- Inappropriate garbage and waste disposal.
- Pollution from multiple generators in off-grid locations.
- Misrepresentation of facts in Special Land Use Permit & WSLCB applications.

Marijuana Licensing and Special Land Use

The WSLCB licenses marijuana production and processing facilities according to three tiers of operation: A Tier 1 equals 2,000 sq. ft., Tier 2 equals 10,000 sq. ft., and Tier 3 equals 30,000 sq. ft. of plant canopy (WSLCB, 2017). Prior to November 10, 2015, Tier 1, 2 and 3 marijuana operations were allowed in rural residential and agricultural zones by Thurston County Long Range Planning Resource Stewardship (Board of Thurston County Commissioners, 2013). These early Interim Ordinances did not specify that neighboring residents were to be notified, or given a comment period, regarding a marijuana production and processing application for Special Land Use Permit in these zones (Board of Thurston County Commissioners, 2013). As of November 10, 2015, due to concerns expressed by negatively impacted residents at public hearings, (Thurston County Washington, 2014-2016), and following further review by the Board of Thurston County Commissioners (Chalem, 2016), Tier 1, 2 and 3 marijuana

production and processing operations were no longer permitted in rural residential or agricultural areas of Thurston County (Board of Thurston County Commissioners, 2015).

Since 2013 Thurston County Interim Ordinances have stated that applicants who begin construction of *Cannabis* facilities in advance of receiving a Special Land Use Permit, do so “at their own risk” (Board of Thurston County Commissioners, 2013, 2015 & 2016). Prior to November 2015, and in more than one instance, advance construction of marijuana facilities without first being granted Special Land Use Permits, have been contested by negatively impacted residents (Thurston County Washington, 2014-2016). Such situations have led to discussions regarding whether applicants, who developed facilities without permit in rural residential or agricultural zones, can be considered vested and granted permits after the fact due to their financial “at risk” investment (Cushman, 2016; Thurston County Permitting and Land Use, 2017).

Vesting such operations, when affected neighborhoods were never given notice of the applicant or County’s intentions, and where residents have experienced undue harm as a result, should be considered a matter of serious social concern. Despite this, objections have proven challenging for impacted communities due to inadequate protection in Thurston County’s earlier Interim Ordinance regulations (Board of Thurston County Commissioners, 2013; Cushman, 2016 & 2017; Thurston County Washington, 2014-2016; Thurston County Permitting and Land Use, 2017).



Fig. 1. Photograph: Horkings-Brigham, M. (2016). Located on a ten-acre property outside of Yelm, WA, this three-acre area was deforested, graded, and tiered to allow for unpermitted Tier 2 (lower) and Tier 3 (upper) *Cannabis* operations from 2014 – 2017 (Thurston County Permitting and Land Use, 2017).

Thurston County public records demonstrate instances where marijuana applicants have provided misleading information in order to position themselves for a license, or licenses, in a desired location (Fig. 1). These records reveal contradictory statements, environmental degradation, unlicensed production of marijuana, and multiple building code violations in at least one well-documented case (Cushman, 2016 & 2017; Thurston County Permitting and Land Use, 2017). Challenging such situations could continue to cause unsettling disputes, as well as economic and other stresses, to property owners neighboring large-scale, commercial *Cannabis* operations located in Thurston County's rural residential and agricultural neighborhoods (Thurston County Washington, 2014-2016).

CANNABIS CULTIVATION

As technology and know-how increased, so did the ease of growing *Cannabis*. With equipment and information readily available online, marijuana can now be produced just about anywhere. Expertise describing trade practices can be distributed via a multitude of sources including word-of-mouth, underground communication networks, the internet, grow shops, and magazines (Decorte & Potter, 2015).

Production Methods

Growers cultivate marijuana for the leaves and flowers harvested from the female *Cannabis sativa* plant (Bogdanoski, 2010 p. 509) using a variety of methods. Clones taken from mother plants establish crops of all-females whose flowering periods can be artificially encouraged through responses to diurnal dark periods (Cervantes, 2006). This technique, called "simsinella," produces the highest concentration of delta-9-tetrahydrocannabinol (THC), marijuana's main psychoactive ingredient (Bogdanoski, 2010 p. 510). Manipulating harvest cycles indoors through the simsinella technique can significantly increase production (Piljman et al, 2005 p. 178; Sweet, 2016 p. 13).

Marijuana production is energy intensive (O'Hare et al, 2013 p. 4). Mother plants and clones require 18–24 hours of light per day, reduced to 12 hours at critical times to induce flowering (Cervantes, 2006). Greenhouse cultivation is said to be less energy intensive than indoor methods (O'Hare et al, 2013 p. 7) however, additional heat, light, and air circulation are necessary in Washington State's climate to facilitate high production levels. Energy consumed at outdoor sites is significantly less than with indoor or greenhouse cultivation (O'Hare et al, 2013 p. 8), yet outdoor methods would produce lower yields in Washington's seasonal climate. Where poor regulatory oversight and mismanagement exist, outdoor operations have created multiple ecological problems through deforestation, and degradation to wetlands from chemical waste runoff and land conversion (Mills 2012 p. 63; Bauer et al, 2015).

In 2013, recommendations to the WSLCB favored *Cannabis* cultivation in "standard greenhouses" rather than construction of "high-security greenhouses," and in preference to indoor growing operations (O'Hare et al, 2013 p. 24). Although O'Hare's team stated at the time that compared

to indoor production, *Cannabis* produced in greenhouses entails “lower energy consumption, GHG [Greenhouse Gas Emission] production, water consumption, wastewater production, fertilizer application, and toxic risks” (2013 p. 24), these findings require further study. Water and energy consumption, pollutants in industrial wastewater, storm water runoff, and greenhouse gas emissions (GHGs), could all prove to be more efficiently managed in indoor operations as marijuana’s commercial production and processing industry develops in Washington State. Standard or high-security greenhouses could demand significantly more energy for heating and lighting during cold periods, and increased ventilation and water consumption during hot summers, than indoor operations. In comparison to an indoor facility, O’Hare, et al. also do not appear to have considered land conversions, or plastic waste products in greenhouse materials (unless glass or similar permanent installation), that can contribute to GHGs (2013).

Commercial production of marijuana in standard greenhouses that lack high security, as suggested by O’Hare’s team (2013 p. 24), could also invite a host of safety concerns to communities neighboring large-scale, commercial marijuana operations. Therefore, indoor production and processing could be considered less intrusive to neighborhood character, while offering greater security to communities, than greenhouse *Cannabis* cultivation.

ENVIRONMENTAL IMPACTS OF MARIJUANA PRODUCTION AND PROCESSING

The horticultural practices of marijuana cultivation have been said to have similar impacts to the environment as an agricultural crop however, mismanaged and unpermitted *Cannabis* growing operations can contribute to increased environmental damage (Short Gianotti et al, 2016 p. 126). Where poor management due to unregulated marijuana operations occur, degradation can include significant carbon dioxide emissions through forest and topsoil depletion from land conversion, damage to wetlands, chemicals polluting land and waterways, human garbage (Fig. 2), diminished surface water, and the consumption of fossil fuels (Bauer et al, 2015; Gabriel et al, 2012; Short Gianotti, 2016 p. 128-129; Mills, 2012 p. 63), all potentially threatening to Thurston County aquifers and natural habitats.



Fig. 2. Photographs: Horkings-Brigham, M. (2016). Construction debris, plastics, Styrofoam, household garbage, and other toxic materials left sitting for months before open burning at an unpermitted Tier 2 and Tier 3 facility outside Yelm, WA (Olympic Region Clean Air Agency, 2016; Thurston County Permitting and Land Use, 2017).

According to the *Regulatory Guidance for Cannabis Operations*, created in partnership with multiple Washington State government agencies (Interagency Resource for Achieving Cooperation, 2015) and posted on the WSLCB website, wastewater from marijuana production and processing activities is considered industrial wastewater and may not be discharged into an individual on-site septic system per state regulations (WSLCB, 2017). All marijuana production and processing wastewater must be discharged to a sewer system as industrial wastewater discharged to an on-site septic system “can damage them and cause harm to the environment” (Interagency Resource for Achieving Cooperation, 2015). Thurston County Interim Ordinances have not adequately addressed marijuana industrial wastewater discharge, therefore a Special Land Use Permit granted to a commercial *Cannabis* operation that is discharging industrial wastewater into an individual on-site septic system could be in violation of state regulations according to IRAC’s report.

Water Consumption

The North Coastal Basin of California provides a clear example of quasi-legal marijuana production causing reduced availability of water in the area. Water diversions and creek drainage became so severe that fish species were threatened in certain places (Bauer et al, 2015 p. 18-19). Similar environmental impacts to watersheds from inadequate oversight of marijuana operations could become problematic among aquatic and riparian-dependent species in Thurston County, especially when one considers climate change, potential water shortages, and the impacts of population growth in Washington State (United States Environmental Protection Agency, 2016).

Water is a major component of *Cannabis* cultivation. Plants require nutrient rich, moist soils with good drainage (Cervantes, 2006; McPartland et al, 2000, p. 9) in order to thrive. Therefore, irrigation is a necessity during dry conditions, with demand varying according to plant maturity, cultivation method, system efficiency, time of year, and location. The State of Washington Department of Ecology (DOE) estimates water consumption for a Tier 3 marijuana operation at 3,900 gallons per day (2016). Bauer et al. state that on average, a single marijuana plant demands 22.7 liters (6 gallons) of water per day during the growing season from June to October in California (2015 p. 2). In comparison, grape vines grown in similar conditions are estimated to use half this amount (Carah et al, 2015 p. 823). According to Bauer’s team, 22.7 liters per day is an estimate taken from the 2010 Humboldt County Outdoor Medical *Cannabis* Ordinance draft (2015 p. 8). Other reports vary widely from 3.8 liters (1 gallon) to 56.8 liters (15 gallons) of water per marijuana plant consumed per day (Bauer et al, 2015 p. 8).

Using Bauer et al.’s estimate of a *Cannabis* plant requiring 1.115 square meters (m²) of space in a greenhouse (2015 p. 7), a Tier 1 operation (185.8 m²) could house approximately 166 plants. Multiply that by the amount of water needed per plant, and total water consumption per day would approximate 3,768 liters (996 gallons). Increase that number by a factor of five for a Tier 2 operation (929 m² =

roughly 830 plants) water consumption would be an estimated 18,840 liters (4,977 gallons) per day. Multiply that by three for a Tier 3 production facility (2,787 m² of plant canopy = roughly 2,500 plants) and the average consumption could amount to a staggering 56,520 liters (14,931 gallons) of water needed per day during production periods. Even with half this quota at 1,250 plants, a Tier 3 operation would be in non-compliance of the DOE's allowance of 5,000 gallons (18,927 liters) of water for commercial/industrial use per day (Cline, 2017). Based on the above calculations, the DOE estimate of 3,900 gpd for a Tier 3 operation is extremely low. This significant discrepancy in water consumption should signal a requirement for meters to be installed at every large-scale marijuana production facility in Washington. At the time of writing meters are not mandated at commercial *Cannabis* operations in Thurston County, unless water consumption is questioned by the DOE in a facility's development and management activities (Cline, 2017; State of Washington Department of Ecology, 2017).

According to the above calculations – depending on seasonal weather conditions, irrigation needs, and methods of cultivation – water usage for Tier 2 and Tier 3 *Cannabis* operations could easily exceed the ground water exemption of 5,000 gpd in commercial/industrial use (Cline, 2017). Therefore, a water right permit should be required as the potential impacts to aquifers through overconsumption could cause significant hardship to rural and agricultural areas throughout Thurston County. Excessive and unregulated water usage from large-scale marijuana operations should be of major concern to the Board of Thurston County Commissioners.

Chemicals and Cannabis

Cannabis is susceptible to a variety of infestations from pests and fungal diseases on stems, leaves, and flowers. Insects, spider mites, aphids, thrips, mice, and rats are pests known to be bothersome to marijuana cultivators (McPartland, 2000 p. 1-8; Stone, 2014 p. 285). Organic cultivation, or growing practices geared toward Integrated Pest Management (IPM) – the holistic method of integrating conventional agricultural pest control with organic practices (McPartland, 2000 p. 2; Stone, 2014 p. 287) – could be applied in marijuana production. However, costs are higher and yields are lower in organic *Cannabis* production than when relying on chemicals to control pests, weeds, disease, and fungus (O'Hare et al, 2013 p. 4). Significant strides have been made in production capabilities of other agriculture crops using IPM technologies, prompting the question of whether or not such application to marijuana cultivation has been adequately encouraged, tested, or analyzed. Although the Washington State Department of Agriculture has prepared a list of approved pesticides for marijuana cultivation (2013), greater training and expertise is needed among *Cannabis* stakeholders (Stone, 2014).

Where dangerously applied and poorly monitored, toxic herbicides, fungicides, and pesticides can lead to serious environmental concerns with the cultivation of marijuana (Bauer et al, 2015). Researchers have noted significant ecological degradation resulting in poisoned wildlife, fish species threatened, and

waterways polluted, due to excessive chemicals applied in quasi-legal marijuana operations in the North Coastal Basin of California and the Sierra National Forest (Bauer et al, 2015; Carah et al, 2015; Gabriel et al, 2012; O’Hare et al, 2013; Short Gianotti et al, 2016; Thompson, 2014). As large-scale marijuana production requires a high use of fertilizers, runoff from such facilities can cause harmful algal blooms and eutrophication of waterways resulting in damage to ecosystems and sensitive habitats (Short Gianotti et al, 2016 p.128). Pesticides ingested by species can enter the food chain and cause harm to wildlife (Bauer et al, 2015 p. 2) and human beings.

With insufficient knowledge, training, and regulation, chemical applications can pose risks to workers, neighboring residents, soils, and watersheds. Public health risks in “do-it-yourself” pesticide use can cause exposures to toxic chemicals in preparation, application, and disposal (Stone, 2014). Agronomic practices using IPM technologies in marijuana cultivation could reduce chemical pollutants present through irrigation, runoff, and erosion. However, micromanagement to ensure such an ethical approach is not likely to be conducted by the WSLCB, or any other government agency.

Another ecological concern associated with the *Cannabis* industry is the improper disposal of high-intensity discharge (HID) lighting materials which are not recyclable, and can increase mercury pollution, and leech other toxic chemicals into the environment (O’Hare et al, 2013 p. 18). A single HID bulb contains approximately 30 mg of the neurotoxin mercury, with contamination estimated to be as high as 30 mg of mercury for every kilogram of marijuana produced when HID materials are not disposed of in a safe manner (O’Hare et al, 2013 p. 18). Conscientious waste management by commercial growers, and the installation of more efficient and less toxic LED lighting systems, is essential to reduce environmental pollutants resulting from large-scale *Cannabis* cultivation.

Greenhouse Gas Emissions (GHGs)

GHGs can be released through multiple-acre marijuana operations in varying amount, depending on whether outdoor, greenhouse, or an indoor installation is utilized. Alterations to land cover type can also contribute to GHG release. CO₂ emission from *Cannabis* production has been estimated at 15 million metric tons, or the equivalent of 3 million average American cars (Mills, 2012, p. 59). Fossil fuels contribute to GHGs when consumed by off-grid marijuana facilities using generators, in vehicle transport, or indirect inputs such as fertilizer production. Depending on the type of generator, it can take up to 70 gallons of diesel fuel, or 140 gallons of gasoline, to grow one indoor marijuana plant (Mills, 2012 p. 59). According to these calculations, if a plant needs approximately 1.115 m² of grow space (Bauer et al, 2015 p. 7), then an off-grid Tier 1 operation allowing for roughly 166 plants, could consume 11,620 gallons of diesel, or up to 23,240 gallons of gasoline, per harvest cycle. Public records describe one such example in the use of multiple generators operating large-scale unpermitted marijuana cultivation on the outskirts of Yelm, WA in 2016 (Cushman, 2016; Thurston County Permitting and Land Use. 2017).

One *Cannabis* cigarette is said to contribute 1.5 kg (3 pounds) of CO₂ emitted to the atmosphere (Mills, 2012 p. 60). While one kilogram of processed marijuana is estimated to emit 4,600 kg (10,141 pounds) of CO₂ (Fig. 3) – doubling when diesel generators are used to power operations (Mills, 2012 p. 60). Carbon dioxide is often injected into grow facilities through natural gas or propane fueled CO₂ generators to enhance plant growth and increase yield (O’Hare et al, 2013 p. 6). Propane or natural gas used in production, heating, and processing (Mills, 2012 p. 59) also contributes to the industry’s carbon footprint.



Fig. 3. Mills, E. (2012). The carbon footprint of indoor *Cannabis* production. *Energy Policy* 46, p. 60.

Research has determined that indoor *Cannabis* operations could significantly reduce GHG emissions by concentrating lighting and cooling requirements during nighttime hours when the load on power is reduced and in less demand (O’Hare et al, 2013 p. 9; Sweet, 2016).

Land Conversion and Storm Runoff

Illegal deforestation, grading, and terracing have been common practices in marijuana cultivation. Large areas have been flattened and deforested to install roads, greenhouses, outdoor grow areas, and parking (Bauer et al, 2015). Land conversions on a hillside above a large wetland area (Fig. 4) has been well-documented in at least two unpermitted marijuana operations in Thurston County (Cushman, 2016; Thurston County Permitting and Land Use, 2017).



Fig. 4. Photograph: Horkings-Brigham, M. (2015). Unpermitted deforestation and land conversion on 3 acres of hillside in marijuana operations close to a large wetland area outside of Yelm, WA (Thurston County Permitting and Land Use, 2017).

Land management of marijuana operations can be difficult to monitor in out-of-sight developments on private property. In California, researchers have been hindered in collecting detailed assessments of environmental damage from *Cannabis* cultivation due to concerns about safety and retaliation (Short Gianotti et al, 2016 p. 129). According to Short Gianotti, the secretive nature and political forces at play limit empirical study of the environmental impacts of marijuana cultivation (2016, p. 129). Zoning marijuana operations in rural residential and agricultural areas of Thurston County could, and have posed, similar problems in managing environmental degradation (Thurston County Washington, 2014-2016). This is especially true where an obscure location hinders adequate oversight of undesirable behavior.

Energy Consumption

The energy intensity of marijuana production and processing in Washington State is not yet widely researched. Although regulations have been implemented to control air and water quality, the large amount of electricity needed to run lights and climate controls in indoor and greenhouse operations requires more in-depth study (Sweet, 2016).

Research conducted in 2012 estimated that 1% of all electricity usage in the US, or the equivalent of 2 million average homes, was consumed in the cultivation of *Cannabis*, at a cost of \$6 billion (Mills, 2012 p. 59). A room measuring 4'x4'x8' producing 4 *Cannabis* plants was estimated to consume 13,000 kWh/year in electricity for lighting, dehumidification, ventilation, irrigation, heating, cooling, and processing in standard operations (Mills, 2012 p. 59). In the United States, generation of electricity from

power plants is the largest contributor of greenhouse gas emissions (U.S. Environmental Protection Agency, 2016 p. 7 & 13).

Although outdoor is less energy intensive than greenhouse or indoor production, higher potency *Cannabis* is believed to be best obtained through indoor cultivation, thereby driving consumer influence (Mills, 2012 p. 62-63). By initiating more energy efficient systems design in indoor marijuana operations, energy consumption could be reduced by at least 75% (Mills, 2012 p. 61) and potentially make indoor marijuana cultivation a more viable alternative to greenhouse operations in Washington State.

THE SOCIAL IMPACTS OF MARIJUANA PRODUCTION AND PROCESSING

Since 2014, the Board of Thurston County Commissioners has held multiple public hearings to obtain input in finalizing regulations that would govern marijuana production and processing in the County (Thurston County Washington, 2014-2016). In November 2015, upon review of public input, Commissioners voted to remove zoning of Tier 1, 2 and 3 marijuana operations from rural residential and agricultural zones (Board of Thurston County Commissioners, 2015). However, less than a year later, on September 20, 2016, a final Ordinance proposed to return commercial marijuana production and processing facilities to these areas (Thurston County Long Range Planning Resource Stewardship Department, 2016). Public protest was immediate, resulting in the extension of the current Ordinance No. 15292 (Board of Thurston County Commissioners, 2016). Protests from more than 80 concerned residents indicate that communities do not favor large-scale, commercial *Cannabis* operations in rural residential or agricultural zones in Thurston County. Concerns involved pollution, crime, loss of neighborhood character, reduced property value, environmental degradation, safety, and traffic (Thurston County Washington, 2014-2016).

Noise, Air, and Light Pollution

Commercial *Cannabis* operations located in remote, rural areas can have limited or no access to electricity, prompting producers to install one or more generators to power off-grid facilities (O'Hare et al, 2013 p. 19; Mills, 2012 p. 59). Due to the high energy demand of marijuana production, the constant pollution and drone of generators and industrial-sized fans can be an annoyance that diminishes quality of life to neighboring residents. Dogs brought in to patrol cultivation sites can be a threat to pets, wildlife, and livestock, and cause significant noise disturbance (Thurston County Permitting and Land Use, 2017). Large-acreage, multiple greenhouse operations, facilitating thousands of square feet of marijuana plant canopy, can significantly alter neighborhood character where constant night-lighting is required to facilitate diurnal cultivation methods.

The *Cannabis* plant emits a strong, skunk-like odor that can permeate neighboring properties when air isn't adequately ventilated or "scrubbed." Outdoor marijuana growth operations have little

chance of scrubbing air and preventing odor from penetrating neighboring properties. Indoor operations can install effective air-filtration systems, while in greenhouses, opening sides and windows during hot weather allows odors to naturally escape into the environment. Marijuana producers and processors are subject to air quality requirements in order to reduce odor and air pollution (Washington State Liquor and Cannabis Board, 2015), yet this can be challenging to regulate in more remote areas.

Safety Concerns

The WSLCB requires 8' high chain-link fencing and security cameras surrounding the perimeter of commercial marijuana facilities (WSLCB, 2017). Such security requirements make large-scale marijuana operations appear at odds with agricultural, rural, residential, or forested natural settings (Thurston County Washington, 2014-2016). Public records demonstrate that despite legalization of marijuana production and processing, unauthorized activities still appear to have operated at some locations in rural residential areas of Thurston County (Cushman, 2016; Thurston County Permitting and Land Use, 2017). Although uncharacteristic of rural landscapes, *Cannabis* producers argue that production sites in the countryside offer lower costs in land acquisition, development, and rent (Thurston County Washington, 2014-2016).

Research has suggested that more restrictive regulatory models introduced in the commercialization of *Cannabis* could better protect the public from criminal activity (Hammersvik et al, 2012; Nguyen et al, 2014). Decorte and Potter conclude that in general, small-scale cultivators of marijuana do not cause significant problems for people or the environment. Large-scale marijuana operations, on the other hand, have historically exhibited greater social harm and disruption (2015 p. 223) indicating that such operations would be better suited to industrial or commercial zones than rural residential or agricultural areas.

Other safety concerns are the risk of hazardous fires and explosions that have been reported in the media as a result of volatile extraction methods used in marijuana processing. "Blasting" is a dangerous method of extracting Butane Hash Oil (BHO) from *Cannabis*. The flammability of butane has caused a number of home explosions (Subritzky, 2015 p. 5) potentially increasing the risk of fire hazards under dry conditions.

Inadequate training and a lack of certification in the application of pesticides is also said to be a safety concern in the marijuana industry (Stone, 2014 p. 287), thereby posing health risks to workers, neighbors, pets, and wildlife.

The Oregon Veterinary Medical Association warns pet owners about the risk of animals ingesting improperly stored pesticides, inhaling marijuana smoke, eating the plants, or consuming *Cannabis* manufactured products such as cookies and chocolates (2017).

Increased Traffic

Despite being relatively easy to grow, marijuana requires regular attention to sustain a healthy and productive crop (McPartland et al, 2000). Therefore, according to the WSLCB, up to 150 workers can be employed depending on the size and plant production cycle of the operation (Thurston County Washington, 2017). Size increases traffic to and from a site, posing additional challenges to unaccustomed neighbors safeguarding pets and young children. Maintaining road conditions can be difficult, depending on location, as private roads not under County jurisdiction can leave neighbors with the additional expense of maintaining a degraded easement due to increased traffic serving a *Cannabis* operation (Thurston County Permitting and Land Use, 2017).

FUTURE RECOMMENDATIONS

Commercial marijuana production and processing facilities are not compatible with rural neighborhood character. They also endanger the safety of rural residents and ecosystem functioning. Based on the potentially harmful social and environmental impacts, zoning of *Cannabis* operations in rural residential or agricultural areas is irresponsible and should be limited to commercial or industrial zones only. Commercial and industrial zones allow greater access to regulatory oversight, security, industrial wastewater sewer facilities, and access to power. Further, they've already been deforested, so overall environmental impact would seem to be less damaging. Recommendations to consider in a final Thurston County Ordinance regulating marijuana production and processing are the following:

- Neighborhood character, community safety, and environmental protection must be considered a priority in any final Ordinance.
- Water meters should be installed at all commercial marijuana production and processing facilities, with regular inspections to ensure consumption does not exceed legal allowance.
- Industrial wastewater from commercial marijuana production and processing should not be discharged into individual on-site septic systems.
- Prior to each application an extensive State Environmental Policy Act (SEPA) review of the entire area should be conducted to ensure habitat, aquifer, and watershed protection.
- All government agencies should collaborate in the permitting process. This would include regular communication between the Washington State Liquor and Cannabis Board, Olympic Region Clean Air Agency, Washington State Department of Fish and Wildlife, Washington State Department of Ecology, the State Environmental Protection Agency, Thurston County Resource Stewardship, Thurston County Law Enforcement, and waste disposal agencies.
- Neighboring properties within a mile radius should be notified at the time an application is submitted, provided all information related to the intended activity, and given 90 days to respond before any processing of a Special Land Use Permit application is initiated.

- No construction should be allowed to commence prior to receiving Special Land Use Permit, and ONLY following consent from the neighboring community.
- Applicants who pursue construction without prior neighborhood consent, or first obtaining a Thurston County Special Land Use Permit, should not be considered vested.
- Marijuana operations discharging industrial wastewater from production and processing into an individual on-site septic system should not be vested.
- Any application demonstrating misrepresentation of facts, or other deceptive measures in submitting an application, or repeatedly ignored violation notices resulting in closure of an application, should be denied a Special Land Use Permit in Thurston County.
- Marijuana cultivation is better suited indoors where production, processing, air circulation, temperature, light, security, pests, irrigation, power consumption, industrial wastewater discharge, garbage disposal, odor, and noise can be best monitored and controlled, thereby creating less impact to neighboring communities.
- Tier 1, 2 and 3 commercial/industrial marijuana production and processing operations should be zoned in industrial or commercial areas only.
- Cooperatives should be limited to commercial zones only.

CONCLUSION

Wise considerations in location, land conversion, air quality, odor reduction, pollution (noise, soil, water, and light pollution), and neighborhood character and safety are crucial to ensure social and environmental well-being in the zoning of commercial *Cannabis* operations.

Evidence suggests the need for strong regulations to protect communities and ecosystems, with government officials weighing a responsibility toward citizens and the environment when deciding upon a final Ordinance to regulate marijuana operations in Thurston County. Decision-makers should review all public concerns, especially where experience has demonstrated harm to neighborhoods as a result of insufficient regulations in prior Ordinances, while also balancing the needs of a flourishing industry.

As a result of this research, indoor growing operations located in industrial or commercial zones appear to offer the highest assurance of public and environmental safety. Only by ensuring that citizens' lives and property are not unduly disrupted by the introduction of an industry with a long history of criminal activity, can Thurston County and Washington State be assured of a productive relationship between *Cannabis* enthusiasts, business entrepreneurs, and the general populace, as this industry undoubtedly expands throughout the country.

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Marijuana’s Impact on Communities and the Environment:

WHAT THURSTON COUNTY SHOULD CONSIDER

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(Revisions made to size of Tier 1 (2,000 sq. ft.), vesting and cooperatives under “Future Recommendations,”
employment estimates under “Increased Traffic.”)

INTRODUCTION

Following the legalization of marijuana production and processing in Washington State through Initiative 502 (I-502) in 2012, government regulations should be expected to protect citizens from any harmful effects associated with this developing industry. In reviewing the literature, it is difficult to find scientific studies that analyze the social or environmental impacts of commercial marijuana operations zoned in rural residential or agricultural neighborhoods. Although there is evidence of public complaint regarding the negative effects to communities from large-scale *Cannabis* facilities, there is a lack of in-depth studies on those impacts. In investigating the information available, two questions are posed: What potential environmental impacts should be addressed when creating a final Ordinance that governs large-scale marijuana production and processing operations? What social concerns should be considered when drafting a final Ordinance to regulate marijuana production and processing operations in Thurston County?

This paper synthesizes existing research on the potentially harmful effects of commercial *Cannabis* cultivation to natural ecosystems and neighboring communities. Until November 10, 2015, zoning and regulations in Thurston County’s Interim Ordinances governing marijuana commercial operations in the County failed to protect rural residents from a myriad of issues that include: unsightly land conversion, deforestation, unpermitted grading and construction, toxic waste, unregulated marijuana cultivation, pollution (air, water, noise and light pollution), greenhouse gas emissions, water consumption, degraded road conditions, crime and neighborhood safety (Thurston County Washington, 2014-2016). This paper informs readers and government officials of arguments that oppose the zoning of commercial marijuana production and processing operations in rural residential and agricultural areas. As a result of these findings, recommendations are made that could provide greater environmental oversight and afford better protection to citizens, habitat, and property when determining a final Ordinance.

The information presented examines 1) community outcomes of earlier interim marijuana production and processing ordinances, 2) *Cannabis* cultivation methods, and 3) the related negative impacts (energy consumption, environmental degradation, and destruction of neighborhood character) that could threaten pristine areas of Thurston County with the inappropriate zoning of this industry.

THURSTON COUNTY'S INTERIM ORDINANCE

In 2012, the passage of I-502 legalized recreational and commercial marijuana production in Washington State. Individuals could now grow *Cannabis* at their own residence, including their backyard. Thurston County has since moved through nine Interim Ordinances regulating the production and processing of marijuana in the past four years (Thurston County Washington, 2017). The delay of a final Ordinance is an indication of the confusion and debate that has surrounded this developing business model since voters legalized the industry in 2012.

In 2013, the Washington State Liquor Control Board, later renamed The Washington State Liquor and Cannabis Board (WSLCB), held 13 public hearings, and met with over 6,000 state residents, in order to draft new regulations to govern the commercial production, processing and distribution of marijuana (Pardo, 2014 p. 729). Though a respectable number among the state's total population – approximately 6,900,000 in 2013 (Office of Financial Management, 2016 p. 19) – determining what percentage were *Cannabis* business enthusiasts that affected baseline policy to regulate this emerging industry, would be an interesting statistic in future studies researching the impacts to neighboring residents.

Applications to produce, process, and distribute marijuana were first accepted in Washington State in December, 2013 (Pardo, 2014 p. 729). Yet thorough investigation into the social and environmental repercussions to communities resulting from this cultural shift are challenging to locate. Without more extensive research, less than fully informed decisions regulating *Cannabis* production and processing made on behalf of residents and property owners in Thurston County may significantly impact quality of life, ecosystem functioning, and neighborhood character.

The peer-reviewed literature could be limited due to the continued classification of *Cannabis* as a Schedule I drug, which is defined as having a high potential for abuse by the US Drug Enforcement Administration (2017), and horticultural plant, not agricultural, by the Federal Government. These definitions led to a gray area in early Interim Ordinances' zoning of commercial marijuana operations in Thurston County. Federal definitions of marijuana as a horticultural plant prompted the Board of Thurston County Commissioners, defending the early zoning of large-scale *Cannabis* operations, to state in 2013 that marijuana production “resembles a type of agricultural use” (Chalem, 2016; Smith, 2015 p. 3; Board of Thurston County Commissioners, 2013). However, written comments and testimony received at public hearings by Thurston County officials over the past two years regarding the zoning of large-

scale marijuana facilities (Thurston County Washington, 2014-2016), has brought attention to the fact that mandated 8' high, chain-link fencing topped with multiple security cameras (WSLCB, 2017), hardly resembles typical agricultural practice.

Concerns surrounding commercial marijuana operations located in rural residential and agricultural areas, as described at Thurston County public hearings and through written correspondence (Thurston County Washington, 2014-2016), include the following:

- Loss of neighborhood character.
- Concerns about personal and family safety.
- Increased criminal activity.
- Large-scale land conversion such as deforestation and earth movement.
- Pest infestations.
- Unpermitted construction of facilities.
- Illegal marijuana production and processing.
- Loss of neighboring property value.
- Risks to children and pets.
- Water, soil, light, noise, and air pollution.
- Intolerable skunk-like odor.
- Overuse of pesticides, rodenticides, and fertilizers.
- Damage to wetland areas.
- Detrimental impacts to habitat, species, and ecosystems.
- Overconsumption of water and depleted aquifers.
- Degraded road conditions.
- Excessive noise from guard dogs, industrial fans, and generators.
- Storm and industrial wastewater runoff.
- Increased traffic.
- Inappropriate garbage and waste disposal.
- Pollution from multiple generators in off-grid locations.
- Misrepresentation of facts in Special Land Use Permit & WSLCB applications.

Marijuana Licensing and Special Land Use

The WSLCB licenses marijuana production and processing facilities according to three tiers of operation: A Tier 1 equals 2,000 sq. ft., Tier 2 equals 10,000 sq. ft., and Tier 3 equals 30,000 sq. ft. of plant canopy (WSLCB, 2017). Prior to November 10, 2015, Tier 1, 2 and 3 marijuana operations were allowed in rural residential and agricultural zones by Thurston County Long Range Planning Resource Stewardship (Board of Thurston County Commissioners, 2013). These early Interim Ordinances did not specify that neighboring residents were to be notified, or given a comment period, regarding a marijuana production and processing application for Special Land Use Permit in these zones (Board of Thurston County Commissioners, 2013). As of November 10, 2015, due to concerns expressed by negatively impacted residents at public hearings, (Thurston County Washington, 2014-2016), and following further review by the Board of Thurston County Commissioners (Chalem, 2016), Tier 1, 2 and 3 marijuana

production and processing operations were no longer permitted in rural residential or agricultural areas of Thurston County (Board of Thurston County Commissioners, 2015).

Since 2013 Thurston County Interim Ordinances have stated that applicants who begin construction of *Cannabis* facilities in advance of receiving a Special Land Use Permit, do so “at their own risk” (Board of Thurston County Commissioners, 2013, 2015 & 2016). Prior to November 2015, and in more than one instance, advance construction of marijuana facilities without first being granted Special Land Use Permits, have been contested by negatively impacted residents (Thurston County Washington, 2014-2016). Such situations have led to discussions regarding whether applicants, who developed facilities without permit in rural residential or agricultural zones, can be considered vested and granted permits after the fact due to their financial “at risk” investment (Cushman, 2016; Thurston County Permitting and Land Use, 2017).

Vesting such operations, when affected neighborhoods were never given notice of the applicant or County’s intentions, and where residents have experienced undue harm as a result, should be considered a matter of serious social concern. Despite this, objections have proven challenging for impacted communities due to inadequate protection in Thurston County’s earlier Interim Ordinance regulations (Board of Thurston County Commissioners, 2013; Cushman, 2016 & 2017; Thurston County Washington, 2014-2016; Thurston County Permitting and Land Use, 2017).



Fig. 1. Photograph: Horkings-Brigham, M. (2016). Located on a ten-acre property outside of Yelm, WA, this three-acre area was deforested, graded, and tiered to allow for unpermitted Tier 2 (lower) and Tier 3 (upper) *Cannabis* operations from 2014 – 2017 (Thurston County Permitting and Land Use, 2017).

Thurston County public records demonstrate instances where marijuana applicants have provided misleading information in order to position themselves for a license, or licenses, in a desired location (Fig. 1). These records reveal contradictory statements, environmental degradation, unlicensed production of marijuana, and multiple building code violations in at least one well-documented case (Cushman, 2016 & 2017; Thurston County Permitting and Land Use, 2017). Challenging such situations could continue to cause unsettling disputes, as well as economic and other stresses, to property owners neighboring large-scale, commercial *Cannabis* operations located in Thurston County's rural residential and agricultural neighborhoods (Thurston County Washington, 2014-2016).

CANNABIS CULTIVATION

As technology and know-how increased, so did the ease of growing *Cannabis*. With equipment and information readily available online, marijuana can now be produced just about anywhere. Expertise describing trade practices can be distributed via a multitude of sources including word-of-mouth, underground communication networks, the internet, grow shops, and magazines (Decorte & Potter, 2015).

Production Methods

Growers cultivate marijuana for the leaves and flowers harvested from the female *Cannabis sativa* plant (Bogdanoski, 2010 p. 509) using a variety of methods. Clones taken from mother plants establish crops of all-females whose flowering periods can be artificially encouraged through responses to diurnal dark periods (Cervantes, 2006). This technique, called "simsinella," produces the highest concentration of delta-9-tetrahydrocannabinol (THC), marijuana's main psychoactive ingredient (Bogdanoski, 2010 p. 510). Manipulating harvest cycles indoors through the simsinella technique can significantly increase production (Piljman et al, 2005 p. 178; Sweet, 2016 p. 13).

Marijuana production is energy intensive (O'Hare et al, 2013 p. 4). Mother plants and clones require 18–24 hours of light per day, reduced to 12 hours at critical times to induce flowering (Cervantes, 2006). Greenhouse cultivation is said to be less energy intensive than indoor methods (O'Hare et al, 2013 p. 7) however, additional heat, light, and air circulation are necessary in Washington State's climate to facilitate high production levels. Energy consumed at outdoor sites is significantly less than with indoor or greenhouse cultivation (O'Hare et al, 2013 p. 8), yet outdoor methods would produce lower yields in Washington's seasonal climate. Where poor regulatory oversight and mismanagement exist, outdoor operations have created multiple ecological problems through deforestation, and degradation to wetlands from chemical waste runoff and land conversion (Mills 2012 p. 63; Bauer et al, 2015).

In 2013, recommendations to the WSLCB favored *Cannabis* cultivation in "standard greenhouses" rather than construction of "high-security greenhouses," and in preference to indoor growing operations (O'Hare et al, 2013 p. 24). Although O'Hare's team stated at the time that compared

to indoor production, *Cannabis* produced in greenhouses entails “lower energy consumption, GHG [Greenhouse Gas Emission] production, water consumption, wastewater production, fertilizer application, and toxic risks” (2013 p. 24), these findings require further study. Water and energy consumption, pollutants in industrial wastewater, storm water runoff, and greenhouse gas emissions (GHGs), could all prove to be more efficiently managed in indoor operations as marijuana’s commercial production and processing industry develops in Washington State. Standard or high-security greenhouses could demand significantly more energy for heating and lighting during cold periods, and increased ventilation and water consumption during hot summers, than indoor operations. In comparison to an indoor facility, O’Hare, et al. also do not appear to have considered land conversions, or plastic waste products in greenhouse materials (unless glass or similar permanent installation), that can contribute to GHGs (2013).

Commercial production of marijuana in standard greenhouses that lack high security, as suggested by O’Hare’s team (2013 p. 24), could also invite a host of safety concerns to communities neighboring large-scale, commercial marijuana operations. Therefore, indoor production and processing could be considered less intrusive to neighborhood character, while offering greater security to communities, than greenhouse *Cannabis* cultivation.

ENVIRONMENTAL IMPACTS OF MARIJUANA PRODUCTION AND PROCESSING

The horticultural practices of marijuana cultivation have been said to have similar impacts to the environment as an agricultural crop however, mismanaged and unpermitted *Cannabis* growing operations can contribute to increased environmental damage (Short Gianotti et al, 2016 p. 126). Where poor management due to unregulated marijuana operations occur, degradation can include significant carbon dioxide emissions through forest and topsoil depletion from land conversion, damage to wetlands, chemicals polluting land and waterways, human garbage (Fig. 2), diminished surface water, and the consumption of fossil fuels (Bauer et al, 2015; Gabriel et al, 2012; Short Gianotti, 2016 p. 128-129; Mills, 2012 p. 63), all potentially threatening to Thurston County aquifers and natural habitats.



Fig. 2. Photographs: Horkings-Brigham, M. (2016). Construction debris, plastics, Styrofoam, household garbage, and other toxic materials left sitting for months before open burning at an unpermitted Tier 2 and Tier 3 facility outside Yelm, WA (Olympic Region Clean Air Agency, 2016; Thurston County Permitting and Land Use, 2017).

According to the *Regulatory Guidance for Cannabis Operations*, created in partnership with multiple Washington State government agencies (Interagency Resource for Achieving Cooperation, 2015) and posted on the WSLCB website, wastewater from marijuana production and processing activities is considered industrial wastewater and may not be discharged into an individual on-site septic system per state regulations (WSLCB, 2017). All marijuana production and processing wastewater must be discharged to a sewer system as industrial wastewater discharged to an on-site septic system “can damage them and cause harm to the environment” (Interagency Resource for Achieving Cooperation, 2015). Thurston County Interim Ordinances have not adequately addressed marijuana industrial wastewater discharge, therefore a Special Land Use Permit granted to a commercial *Cannabis* operation that is discharging industrial wastewater into an individual on-site septic system could be in violation of state regulations according to IRAC’s report.

Water Consumption

The North Coastal Basin of California provides a clear example of quasi-legal marijuana production causing reduced availability of water in the area. Water diversions and creek drainage became so severe that fish species were threatened in certain places (Bauer et al, 2015 p. 18-19). Similar environmental impacts to watersheds from inadequate oversight of marijuana operations could become problematic among aquatic and riparian-dependent species in Thurston County, especially when one considers climate change, potential water shortages, and the impacts of population growth in Washington State (United States Environmental Protection Agency, 2016).

Water is a major component of *Cannabis* cultivation. Plants require nutrient rich, moist soils with good drainage (Cervantes, 2006; McPartland et al, 2000, p. 9) in order to thrive. Therefore, irrigation is a necessity during dry conditions, with demand varying according to plant maturity, cultivation method, system efficiency, time of year, and location. The State of Washington Department of Ecology (DOE) estimates water consumption for a Tier 3 marijuana operation at 3,900 gallons per day (2016). Bauer et al. state that on average, a single marijuana plant demands 22.7 liters (6 gallons) of water per day during the growing season from June to October in California (2015 p. 2). In comparison, grape vines grown in similar conditions are estimated to use half this amount (Carah et al, 2015 p. 823). According to Bauer’s team, 22.7 liters per day is an estimate taken from the 2010 Humboldt County Outdoor Medical *Cannabis* Ordinance draft (2015 p. 8). Other reports vary widely from 3.8 liters (1 gallon) to 56.8 liters (15 gallons) of water per marijuana plant consumed per day (Bauer et al, 2015 p. 8).

Using Bauer et al.’s estimate of a *Cannabis* plant requiring 1.115 square meters (m²) of space in a greenhouse (2015 p. 7), a Tier 1 operation (185.8 m²) could house approximately 166 plants. Multiply that by the amount of water needed per plant, and total water consumption per day would approximate 3,768 liters (996 gallons). Increase that number by a factor of five for a Tier 2 operation (929 m² =

roughly 830 plants) water consumption would be an estimated 18,840 liters (4,977 gallons) per day. Multiply that by three for a Tier 3 production facility (2,787 m² of plant canopy = roughly 2,500 plants) and the average consumption could amount to a staggering 56,520 liters (14,931 gallons) of water needed per day during production periods. Even with half this quota at 1,250 plants, a Tier 3 operation would be in non-compliance of the DOE's allowance of 5,000 gallons (18,927 liters) of water for commercial/industrial use per day (Cline, 2017). Based on the above calculations, the DOE estimate of 3,900 gpd for a Tier 3 operation is extremely low. This significant discrepancy in water consumption should signal a requirement for meters to be installed at every large-scale marijuana production facility in Washington. At the time of writing meters are not mandated at commercial *Cannabis* operations in Thurston County, unless water consumption is questioned by the DOE in a facility's development and management activities (Cline, 2017; State of Washington Department of Ecology, 2017).

According to the above calculations – depending on seasonal weather conditions, irrigation needs, and methods of cultivation – water usage for Tier 2 and Tier 3 *Cannabis* operations could easily exceed the ground water exemption of 5,000 gpd in commercial/industrial use (Cline, 2017). Therefore, a water right permit should be required as the potential impacts to aquifers through overconsumption could cause significant hardship to rural and agricultural areas throughout Thurston County. Excessive and unregulated water usage from large-scale marijuana operations should be of major concern to the Board of Thurston County Commissioners.

Chemicals and Cannabis

Cannabis is susceptible to a variety of infestations from pests and fungal diseases on stems, leaves, and flowers. Insects, spider mites, aphids, thrips, mice, and rats are pests known to be bothersome to marijuana cultivators (McPartland, 2000 p. 1-8; Stone, 2014 p. 285). Organic cultivation, or growing practices geared toward Integrated Pest Management (IPM) – the holistic method of integrating conventional agricultural pest control with organic practices (McPartland, 2000 p. 2; Stone, 2014 p. 287) – could be applied in marijuana production. However, costs are higher and yields are lower in organic *Cannabis* production than when relying on chemicals to control pests, weeds, disease, and fungus (O'Hare et al, 2013 p. 4). Significant strides have been made in production capabilities of other agriculture crops using IPM technologies, prompting the question of whether or not such application to marijuana cultivation has been adequately encouraged, tested, or analyzed. Although the Washington State Department of Agriculture has prepared a list of approved pesticides for marijuana cultivation (2013), greater training and expertise is needed among *Cannabis* stakeholders (Stone, 2014).

Where dangerously applied and poorly monitored, toxic herbicides, fungicides, and pesticides can lead to serious environmental concerns with the cultivation of marijuana (Bauer et al, 2015). Researchers have noted significant ecological degradation resulting in poisoned wildlife, fish species threatened, and

waterways polluted, due to excessive chemicals applied in quasi-legal marijuana operations in the North Coastal Basin of California and the Sierra National Forest (Bauer et al, 2015; Carah et al, 2015; Gabriel et al, 2012; O’Hare et al, 2013; Short Gianotti et al, 2016; Thompson, 2014). As large-scale marijuana production requires a high use of fertilizers, runoff from such facilities can cause harmful algal blooms and eutrophication of waterways resulting in damage to ecosystems and sensitive habitats (Short Gianotti et al, 2016 p.128). Pesticides ingested by species can enter the food chain and cause harm to wildlife (Bauer et al, 2015 p. 2) and human beings.

With insufficient knowledge, training, and regulation, chemical applications can pose risks to workers, neighboring residents, soils, and watersheds. Public health risks in “do-it-yourself” pesticide use can cause exposures to toxic chemicals in preparation, application, and disposal (Stone, 2014). Agronomic practices using IPM technologies in marijuana cultivation could reduce chemical pollutants present through irrigation, runoff, and erosion. However, micromanagement to ensure such an ethical approach is not likely to be conducted by the WSLCB, or any other government agency.

Another ecological concern associated with the *Cannabis* industry is the improper disposal of high-intensity discharge (HID) lighting materials which are not recyclable, and can increase mercury pollution, and leech other toxic chemicals into the environment (O’Hare et al, 2013 p. 18). A single HID bulb contains approximately 30 mg of the neurotoxin mercury, with contamination estimated to be as high as 30 mg of mercury for every kilogram of marijuana produced when HID materials are not disposed of in a safe manner (O’Hare et al, 2013 p. 18). Conscientious waste management by commercial growers, and the installation of more efficient and less toxic LED lighting systems, is essential to reduce environmental pollutants resulting from large-scale *Cannabis* cultivation.

Greenhouse Gas Emissions (GHGs)

GHGs can be released through multiple-acre marijuana operations in varying amount, depending on whether outdoor, greenhouse, or an indoor installation is utilized. Alterations to land cover type can also contribute to GHG release. CO₂ emission from *Cannabis* production has been estimated at 15 million metric tons, or the equivalent of 3 million average American cars (Mills, 2012, p. 59). Fossil fuels contribute to GHGs when consumed by off-grid marijuana facilities using generators, in vehicle transport, or indirect inputs such as fertilizer production. Depending on the type of generator, it can take up to 70 gallons of diesel fuel, or 140 gallons of gasoline, to grow one indoor marijuana plant (Mills, 2012 p. 59). According to these calculations, if a plant needs approximately 1.115 m² of grow space (Bauer et al, 2015 p. 7), then an off-grid Tier 1 operation allowing for roughly 166 plants, could consume 11,620 gallons of diesel, or up to 23,240 gallons of gasoline, per harvest cycle. Public records describe one such example in the use of multiple generators operating large-scale unpermitted marijuana cultivation on the outskirts of Yelm, WA in 2016 (Cushman, 2016; Thurston County Permitting and Land Use. 2017).

One *Cannabis* cigarette is said to contribute 1.5 kg (3 pounds) of CO₂ emitted to the atmosphere (Mills, 2012 p. 60). While one kilogram of processed marijuana is estimated to emit 4,600 kg (10,141 pounds) of CO₂ (Fig. 3) – doubling when diesel generators are used to power operations (Mills, 2012 p. 60). Carbon dioxide is often injected into grow facilities through natural gas or propane fueled CO₂ generators to enhance plant growth and increase yield (O’Hare et al, 2013 p. 6). Propane or natural gas used in production, heating, and processing (Mills, 2012 p. 59) also contributes to the industry’s carbon footprint.



Fig. 3. Mills, E. (2012). The carbon footprint of indoor *Cannabis* production. *Energy Policy* 46, p. 60.

Research has determined that indoor *Cannabis* operations could significantly reduce GHG emissions by concentrating lighting and cooling requirements during nighttime hours when the load on power is reduced and in less demand (O’Hare et al, 2013 p. 9; Sweet, 2016).

Land Conversion and Storm Runoff

Illegal deforestation, grading, and terracing have been common practices in marijuana cultivation. Large areas have been flattened and deforested to install roads, greenhouses, outdoor grow areas, and parking (Bauer et al, 2015). Land conversions on a hillside above a large wetland area (Fig. 4) has been well-documented in at least two unpermitted marijuana operations in Thurston County (Cushman, 2016; Thurston County Permitting and Land Use, 2017).



Fig. 4. Photograph: Horkings-Brigham, M. (2015). Unpermitted deforestation and land conversion on 3 acres of hillside in marijuana operations close to a large wetland area outside of Yelm, WA (Thurston County Permitting and Land Use, 2017).

Land management of marijuana operations can be difficult to monitor in out-of-sight developments on private property. In California, researchers have been hindered in collecting detailed assessments of environmental damage from *Cannabis* cultivation due to concerns about safety and retaliation (Short Gianotti et al, 2016 p. 129). According to Short Gianotti, the secretive nature and political forces at play limit empirical study of the environmental impacts of marijuana cultivation (2016, p. 129). Zoning marijuana operations in rural residential and agricultural areas of Thurston County could, and have posed, similar problems in managing environmental degradation (Thurston County Washington, 2014-2016). This is especially true where an obscure location hinders adequate oversight of undesirable behavior.

Energy Consumption

The energy intensity of marijuana production and processing in Washington State is not yet widely researched. Although regulations have been implemented to control air and water quality, the large amount of electricity needed to run lights and climate controls in indoor and greenhouse operations requires more in-depth study (Sweet, 2016).

Research conducted in 2012 estimated that 1% of all electricity usage in the US, or the equivalent of 2 million average homes, was consumed in the cultivation of *Cannabis*, at a cost of \$6 billion (Mills, 2012 p. 59). A room measuring 4'x4'x8' producing 4 *Cannabis* plants was estimated to consume 13,000 kWh/year in electricity for lighting, dehumidification, ventilation, irrigation, heating, cooling, and processing in standard operations (Mills, 2012 p. 59). In the United States, generation of electricity from

power plants is the largest contributor of greenhouse gas emissions (U.S. Environmental Protection Agency, 2016 p. 7 & 13).

Although outdoor is less energy intensive than greenhouse or indoor production, higher potency *Cannabis* is believed to be best obtained through indoor cultivation, thereby driving consumer influence (Mills, 2012 p. 62-63). By initiating more energy efficient systems design in indoor marijuana operations, energy consumption could be reduced by at least 75% (Mills, 2012 p. 61) and potentially make indoor marijuana cultivation a more viable alternative to greenhouse operations in Washington State.

THE SOCIAL IMPACTS OF MARIJUANA PRODUCTION AND PROCESSING

Since 2014, the Board of Thurston County Commissioners has held multiple public hearings to obtain input in finalizing regulations that would govern marijuana production and processing in the County (Thurston County Washington, 2014-2016). In November 2015, upon review of public input, Commissioners voted to remove zoning of Tier 1, 2 and 3 marijuana operations from rural residential and agricultural zones (Board of Thurston County Commissioners, 2015). However, less than a year later, on September 20, 2016, a final Ordinance proposed to return commercial marijuana production and processing facilities to these areas (Thurston County Long Range Planning Resource Stewardship Department, 2016). Public protest was immediate, resulting in the extension of the current Ordinance No. 15292 (Board of Thurston County Commissioners, 2016). Protests from more than 80 concerned residents indicate that communities do not favor large-scale, commercial *Cannabis* operations in rural residential or agricultural zones in Thurston County. Concerns involved pollution, crime, loss of neighborhood character, reduced property value, environmental degradation, safety, and traffic (Thurston County Washington, 2014-2016).

Noise, Air, and Light Pollution

Commercial *Cannabis* operations located in remote, rural areas can have limited or no access to electricity, prompting producers to install one or more generators to power off-grid facilities (O'Hare et al, 2013 p. 19; Mills, 2012 p. 59). Due to the high energy demand of marijuana production, the constant pollution and drone of generators and industrial-sized fans can be an annoyance that diminishes quality of life to neighboring residents. Dogs brought in to patrol cultivation sites can be a threat to pets, wildlife, and livestock, and cause significant noise disturbance (Thurston County Permitting and Land Use, 2017). Large-acreage, multiple greenhouse operations, facilitating thousands of square feet of marijuana plant canopy, can significantly alter neighborhood character where constant night-lighting is required to facilitate diurnal cultivation methods.

The *Cannabis* plant emits a strong, skunk-like odor that can permeate neighboring properties when air isn't adequately ventilated or "scrubbed." Outdoor marijuana growth operations have little

chance of scrubbing air and preventing odor from penetrating neighboring properties. Indoor operations can install effective air-filtration systems, while in greenhouses, opening sides and windows during hot weather allows odors to naturally escape into the environment. Marijuana producers and processors are subject to air quality requirements in order to reduce odor and air pollution (Washington State Liquor and Cannabis Board, 2015), yet this can be challenging to regulate in more remote areas.

Safety Concerns

The WSLCB requires 8' high chain-link fencing and security cameras surrounding the perimeter of commercial marijuana facilities (WSLCB, 2017). Such security requirements make large-scale marijuana operations appear at odds with agricultural, rural, residential, or forested natural settings (Thurston County Washington, 2014-2016). Public records demonstrate that despite legalization of marijuana production and processing, unauthorized activities still appear to have operated at some locations in rural residential areas of Thurston County (Cushman, 2016; Thurston County Permitting and Land Use, 2017). Although uncharacteristic of rural landscapes, *Cannabis* producers argue that production sites in the countryside offer lower costs in land acquisition, development, and rent (Thurston County Washington, 2014-2016).

Research has suggested that more restrictive regulatory models introduced in the commercialization of *Cannabis* could better protect the public from criminal activity (Hammersvik et al, 2012; Nguyen et al, 2014). Decorte and Potter conclude that in general, small-scale cultivators of marijuana do not cause significant problems for people or the environment. Large-scale marijuana operations, on the other hand, have historically exhibited greater social harm and disruption (2015 p. 223) indicating that such operations would be better suited to industrial or commercial zones than rural residential or agricultural areas.

Other safety concerns are the risk of hazardous fires and explosions that have been reported in the media as a result of volatile extraction methods used in marijuana processing. "Blasting" is a dangerous method of extracting Butane Hash Oil (BHO) from *Cannabis*. The flammability of butane has caused a number of home explosions (Subritzky, 2015 p. 5) potentially increasing the risk of fire hazards under dry conditions.

Inadequate training and a lack of certification in the application of pesticides is also said to be a safety concern in the marijuana industry (Stone, 2014 p. 287), thereby posing health risks to workers, neighbors, pets, and wildlife.

The Oregon Veterinary Medical Association warns pet owners about the risk of animals ingesting improperly stored pesticides, inhaling marijuana smoke, eating the plants, or consuming *Cannabis* manufactured products such as cookies and chocolates (2017).

Increased Traffic

Despite being relatively easy to grow, marijuana requires regular attention to sustain a healthy and productive crop (McPartland et al, 2000). Therefore, according to the WSLCB, up to 150 workers can be employed depending on the size and plant production cycle of the operation (Thurston County Washington, 2017). Size increases traffic to and from a site, posing additional challenges to unaccustomed neighbors safeguarding pets and young children. Maintaining road conditions can be difficult, depending on location, as private roads not under County jurisdiction can leave neighbors with the additional expense of maintaining a degraded easement due to increased traffic serving a *Cannabis* operation (Thurston County Permitting and Land Use, 2017).

FUTURE RECOMMENDATIONS

Commercial marijuana production and processing facilities are not compatible with rural neighborhood character. They also endanger the safety of rural residents and ecosystem functioning. Based on the potentially harmful social and environmental impacts, zoning of *Cannabis* operations in rural residential or agricultural areas is irresponsible and should be limited to commercial or industrial zones only. Commercial and industrial zones allow greater access to regulatory oversight, security, industrial wastewater sewer facilities, and access to power. Further, they've already been deforested, so overall environmental impact would seem to be less damaging. Recommendations to consider in a final Thurston County Ordinance regulating marijuana production and processing are the following:

- Neighborhood character, community safety, and environmental protection must be considered a priority in any final Ordinance.
- Water meters should be installed at all commercial marijuana production and processing facilities, with regular inspections to ensure consumption does not exceed legal allowance.
- Industrial wastewater from commercial marijuana production and processing should not be discharged into individual on-site septic systems.
- Prior to each application an extensive State Environmental Policy Act (SEPA) review of the entire area should be conducted to ensure habitat, aquifer, and watershed protection.
- All government agencies should collaborate in the permitting process. This would include regular communication between the Washington State Liquor and Cannabis Board, Olympic Region Clean Air Agency, Washington State Department of Fish and Wildlife, Washington State Department of Ecology, the State Environmental Protection Agency, Thurston County Resource Stewardship, Thurston County Law Enforcement, and waste disposal agencies.
- Neighboring properties within a mile radius should be notified at the time an application is submitted, provided all information related to the intended activity, and given 90 days to respond before any processing of a Special Land Use Permit application is initiated.

- No construction should be allowed to commence prior to receiving Special Land Use Permit, and ONLY following consent from the neighboring community.
- Applicants who pursue construction without prior neighborhood consent, or first obtaining a Thurston County Special Land Use Permit, should not be considered vested.
- Marijuana operations discharging industrial wastewater from production and processing into an individual on-site septic system should not be vested.
- Any application demonstrating misrepresentation of facts, or other deceptive measures in submitting an application, or repeatedly ignored violation notices resulting in closure of an application, should be denied a Special Land Use Permit in Thurston County.
- Marijuana cultivation is better suited indoors where production, processing, air circulation, temperature, light, security, pests, irrigation, power consumption, industrial wastewater discharge, garbage disposal, odor, and noise can be best monitored and controlled, thereby creating less impact to neighboring communities.
- Tier 1, 2 and 3 commercial/industrial marijuana production and processing operations should be zoned in industrial or commercial areas only.
- Cooperatives should be limited to commercial zones only.

CONCLUSION

Wise considerations in location, land conversion, air quality, odor reduction, pollution (noise, soil, water, and light pollution), and neighborhood character and safety are crucial to ensure social and environmental well-being in the zoning of commercial *Cannabis* operations.

Evidence suggests the need for strong regulations to protect communities and ecosystems, with government officials weighing a responsibility toward citizens and the environment when deciding upon a final Ordinance to regulate marijuana operations in Thurston County. Decision-makers should review all public concerns, especially where experience has demonstrated harm to neighborhoods as a result of insufficient regulations in prior Ordinances, while also balancing the needs of a flourishing industry.

As a result of this research, indoor growing operations located in industrial or commercial zones appear to offer the highest assurance of public and environmental safety. Only by ensuring that citizens' lives and property are not unduly disrupted by the introduction of an industry with a long history of criminal activity, can Thurston County and Washington State be assured of a productive relationship between *Cannabis* enthusiasts, business entrepreneurs, and the general populace, as this industry undoubtedly expands throughout the country.

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