

# NO<sub>2</sub> Exposures and Health Effects in California

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CARB Public Workshop for Indoor NO<sub>2</sub> Guidelines

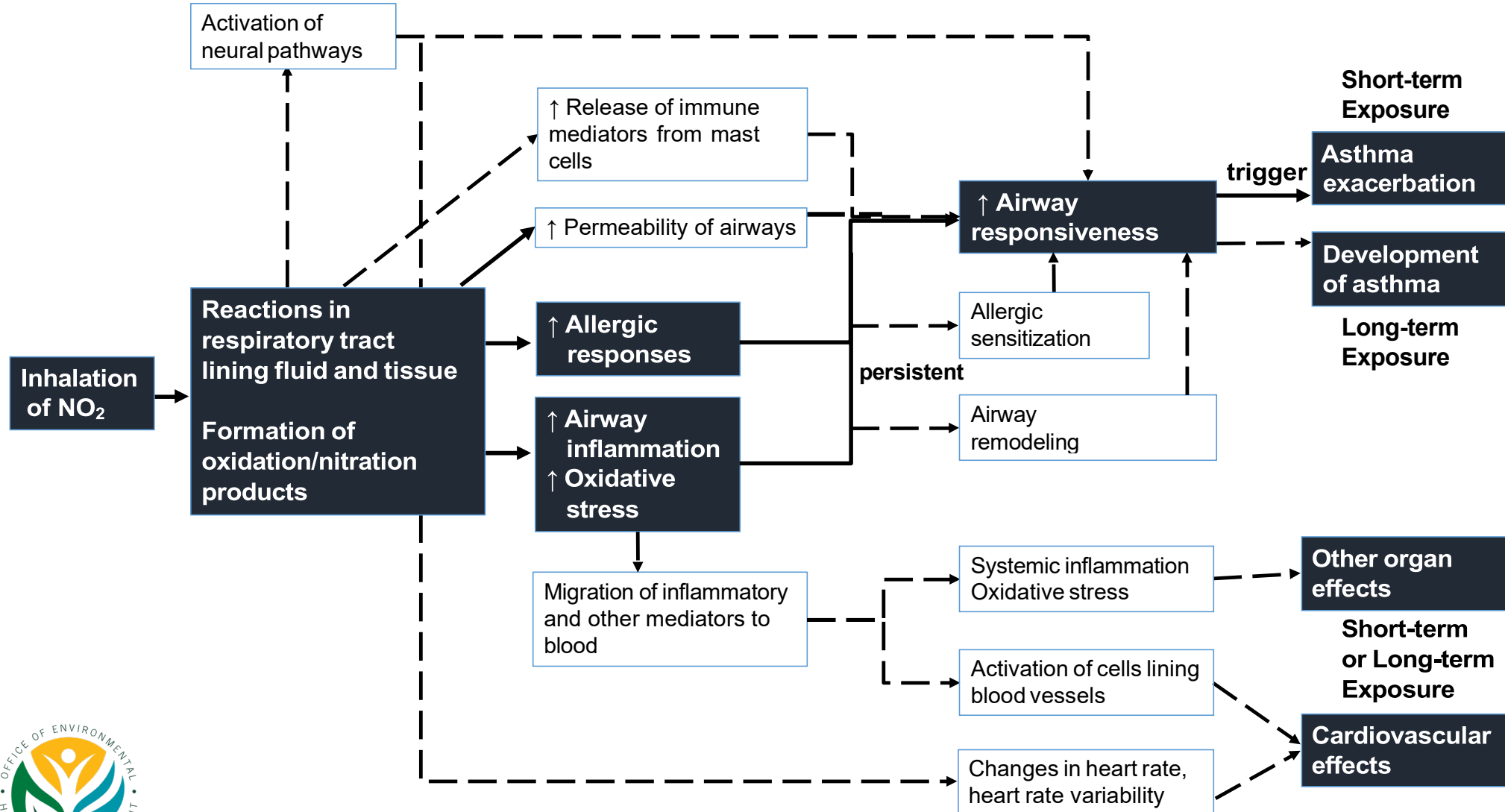
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# Outline

- ▶ Health studies about NO<sub>2</sub> in California
- ▶ Indoor NO<sub>2</sub> levels in California
- ▶ Standard development approach

# Biological Pathways for NO<sub>2</sub> Effects



Confirmed causal relationship between NO<sub>2</sub> exposure and respiratory effects

(USEPA, 2016, Integrated Science Assessment for Oxides of Nitrogen)



# California-Specific Studies on Health Effects of NO<sub>2</sub>

(Ambient concentration or Personal exposure)

- Gauderman et al. 2005
- Cisneros et al. 2021
- Mann et al. 2010
- Meng et al. 2022
- McConnell et al. 2010
- Gauderman et al. 2015
- Garcia et al. 2019
- Delfino et al. 2008
- Goin et al. 2021
- Sun et al. 2022
- Niu et al. 2022
- Green et al. 2015
- Gatto et al. 2014
- Thilakaratne et al. 2020
- Jerrett et al. 2013

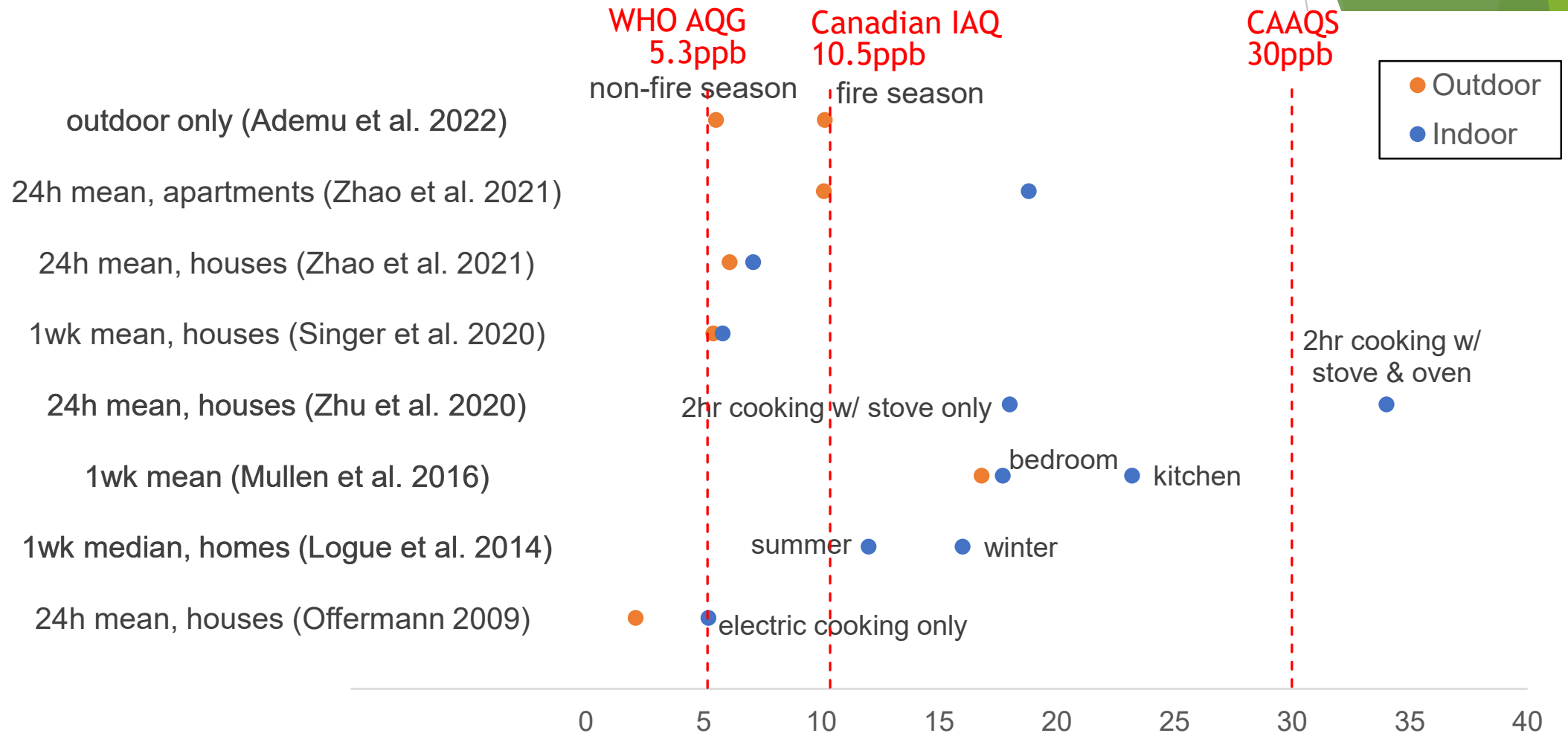
Effects related to pregnancy & childbirth

Respiratory effects

- asthma EDV among children (daily)
- asthma EDV (daily)
- wheeze among children (daily)
- asthma/COPD EDV
- asthma onset among children
- Lung function decrement among children
- asthma onset
- Lung function decrement among children (daily)
- preeclampsia
- gestational diabetes mellitus
- reduced birth weight
- stillbirth
- lower logical memory among adults
- mental health (homicide/inflicted injury) EDV (daily)
- ischemic heart disease

10 15 20 25 30 35 40  
NO<sub>2</sub> (ppb)

# Indoor and Outdoor NO<sub>2</sub> Concentrations in California

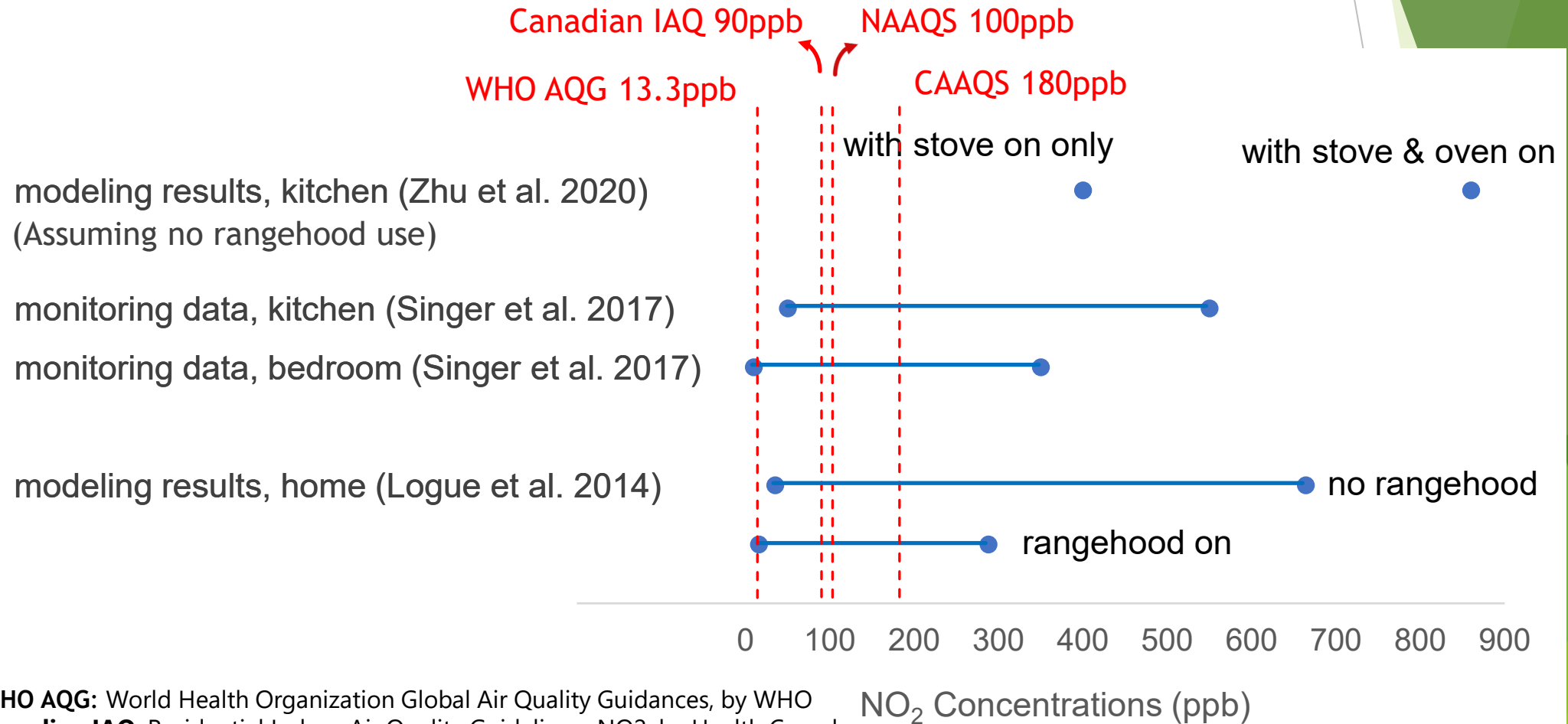


**WHO AQG:** World Health Organization Global Air Quality Guidances, by WHO  
**Canadian IAQ:** Residential Indoor Air Quality Guideline – NO<sub>2</sub>, by Health Canada  
**CAAQS:** California Ambient Air Quality Standards, by CARB

NO<sub>2</sub> Concentrations (ppb)



# Indoor NO<sub>2</sub> Concentrations during Peak Cooking Hours in Californian Residences



**WHO AQG:** World Health Organization Global Air Quality Guidances, by WHO  
**Canadian IAQ:** Residential Indoor Air Quality Guideline – NO<sub>2</sub>, by Health Canada  
**NAAQS:** National Ambient Air Quality Standards, by USEPA  
**CAAQS:** California Ambient Air Quality Standards, by CARB



# Existing Long-term Standard/Guideline (Annual)

	Point of departure and Uncertainty factor (UF)	Standard/Guideline
CAAQS (CARB, 2007)	Changes in lung function growth in children, symptoms in asthmatic children, and preterm birth observed at annual average of 30-44 ppb. No UF adjustment.	57 ug/m <sup>3</sup> (30 ppb)
Residential IAQ Guideline - NO <sub>2</sub> (Health Canada, 2015)	30 ug/m <sup>3</sup> , respiratory symptoms among asthmatic children. UF adjustment: 3 (for use adverse effects level as Point of Departure). RfC: 10 ug/m <sup>3</sup> (5.3 ppb)	20 ug/m <sup>3</sup> (10.5 ppb)
NAAQS (USEPA, most recent reviewed in 2018)	Epidemiologic studies reporting associations between respiratory disease / asthma development in children and long-term exposure to NO <sub>2</sub> . No UF adjustment.	100 ug/m <sup>3</sup> (53 ppb)
WHO Global Air Quality Guidelines (2021)	Based on epi studies of non-accidental mortality and respiratory mortality, 10 ug/m <sup>3</sup> (avg 5 <sup>th</sup> % concentration at 8.8 ug/m <sup>3</sup> ), 25 ug/m <sup>3</sup> (99 <sup>th</sup> % of daily conc corresponding to long-term AQG), No UF adjustment.	10 ug/m <sup>3</sup> (5.3 ppb) (annual) 25 ug/m <sup>3</sup> (13.3 ppb) (daily)

# Existing Short-term Standard/Guideline (1-hour)

	Point of departure and Uncertainty factor (UF)	Standard/Guideline
CAAQS (CARB, 2007)	Increase airway reactivity among asthmatics at 200-300ppb. Adjustment for margin of safety.	339 ug/m <sup>3</sup> (180 ppb)
Residential IAQ Guideline - NO <sub>2</sub> (Health Canada, 2015)	500 ug/m <sup>3</sup> , decreased lung function in subjects with COPD UF adjustment: 10 (3 for use adverse effects level as pod, 3 for human variability) RfC: 50 ug/m <sup>3</sup> (26.5 ppb)	170 ug/m <sup>3</sup> (90 ppb)
NAAQS (USEPA, most recent reviewed in 2018)	Increased airway responses observed in people with asthma at 100-530 ppb; evidence less consistent at 100-200 ppb. No UF adjustment.	188 ug/m <sup>3</sup> (100 ppb) (98%tile 1-hr daily max, avg over 3 yrs)
WHO Global Air Quality Guidelines (2021)	Meta-analysis, bronchial responsiveness among asthmatics, at levels exceeding 200 ug/m <sup>3</sup> , No UF adjustment. adopted from 2000 WHO AQG for Europe	200 ug/m <sup>3</sup> (106 ppb)



# Health Guideline Level Determination

## —— OEHHA's Approach



- 1) Literature review on the lowest level of exposure with adverse outcomes (LOAEL) or highest level without adverse effects (NOAEL)
- 2) Determine point of departure
- 3) Evaluate whether and which uncertainty factors are applicable
- 4) Determine the reference level

# Summary

- Health studies among Californians observed adverse health effects associated with long-term outdoor NO<sub>2</sub> exposure in the range of 10-30 ppb.
- Indoor concentration of NO<sub>2</sub> vary widely. The long-term average indoor NO<sub>2</sub> concentrations in California homes are 5-35 ppb, while the peak NO<sub>2</sub> concentration during cooking hours could reach hundreds of ppb.

# A Potential Path Forward

Step 1: Compile evidence from existing standards, existing reviews, and recent publications, prioritizing CA-specific studies, as feasible

Step 2: Identify key studies and determine the point of departure

Step 3: Evaluate whether uncertainty factors are applicable, depending on the point of departure

Step 4: Determine health reference concentration





# Questions?