6PPD and 6PPD-quinone: Source Reduction

Hazard Criteria, Alternatives Assessment, and the Action Plan

June 2023

Photo: Eiko Jones

Ecology's 3-Part Approach

Reducing sources of 6PPD & evaluating alternatives

AND

Assessing 6PPD-quinone in the environment

AND

Stormwater Best Management Practices (BMPs)

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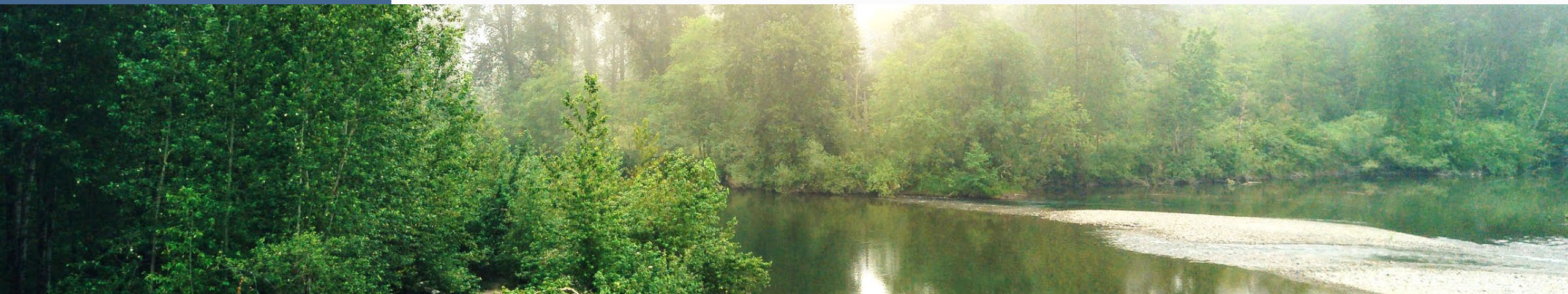
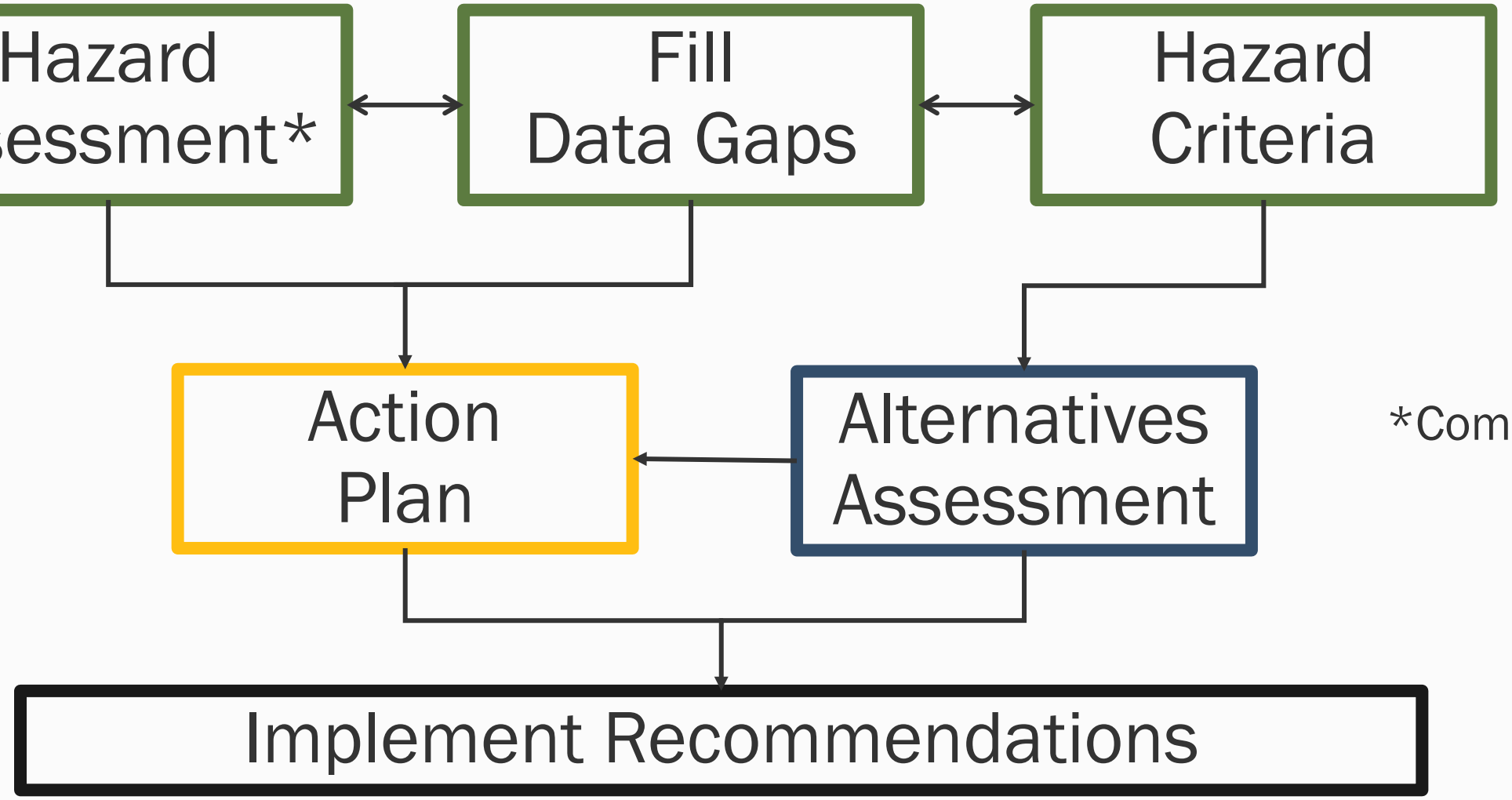
Agenda

- Source Reduction Road Map
- Hazard Assessment
- Filling Data Gaps
- Hazard Criteria
- Alternatives Assessment
- Action Plan



Source Reduction Road Map



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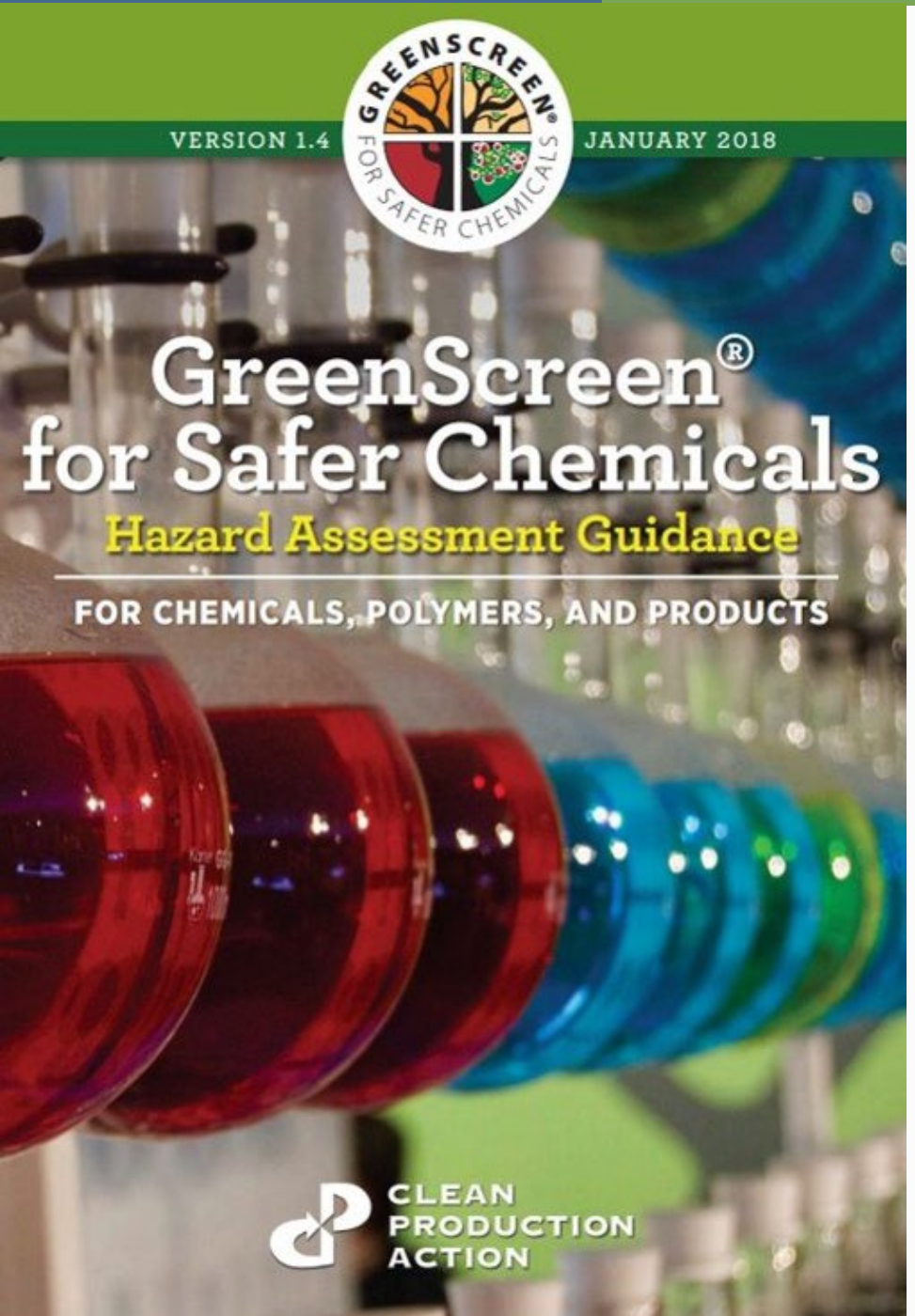


DEPARTMENT OF ECOLOGY
State of Washington

Hazard Assessment

- Completed in November 2021
- Chemicals assessed were selected based on whether they had promise as an anti-degradant in tires, according to:
  - Reviews of journal articles and government reports.
  - Communications with manufacturers and California Department of Toxic Substances Control.

Hazard Assessment - Results

Chemical	GreenScreen® Benchmark Score
6PPD (#793-24-8)	BM-1
77PD (#3081-14-9)	BM-2*
CCPD (#4175-38-6)	BM-1
IPPD (#101-72-4)	BM-1
7PPD (#3081-01-4)	BM-1
TMQ (#26780-96-1)	BM-2*
6QDI (#52870-46-9)	BM-1
NBC (#13927-77-0)	BM-1
Ethoxyquin (#91-53-2)	BM-2*
Dilauryl thiodipropionate (#123-28-4)	BM-3* with data gap

BM-1: Avoid - Chemical of High Concern

BM-2: Use - but search for safer substitutes

BM-3: Use - but still opportunity for improvement

* Chemical has a lower (i.e. safer) score than 6PPD.

Alternatives - Industry Concerns

Alternative	Benchmark	Industry Comments
77PD	BM-2	"…provides a **shorter period of protection than 6PPD**…. It is unclear how long the protection would last in a modern tire." "Equally important is the fact that as a member of the PPD family, it would be **expected to form a quinone like 6PPD**."
TMQ	BM-2	"By itself, it has been shown to have only **52% of the activity of 6PPD**. By itself, it does not provide sufficient antiozonant protection to the rubber."
Ethoxyquin	BM-2	"In early studies, it was shown to be 87% as effective as 6PPD in the initial reaction with ozone….it is **unclear how long protection would last**. It is classified as mildly to moderately toxic."
Dilauryl thiodipropionate	$BM\text{-}3_{DG}$	"It is expected to have **little, if any antiozonant activity**."

Filling Data Gaps

- Learn more about 6PPD and 6PPD-quinone and selected alternatives to develop standard for comparison to other chemicals, including:
  - Analyze toxicity of selected alternative chemicals.
  - Toxicity of 6PPD on rainbow trout and potentially other aquatic species.
  - Environmental condition (like water pH) impacts to toxicity.
- Measure the presence of 6PPD, 6PPD-quinone, and other chemicals present in passenger car, light truck, and commercial truck tires.

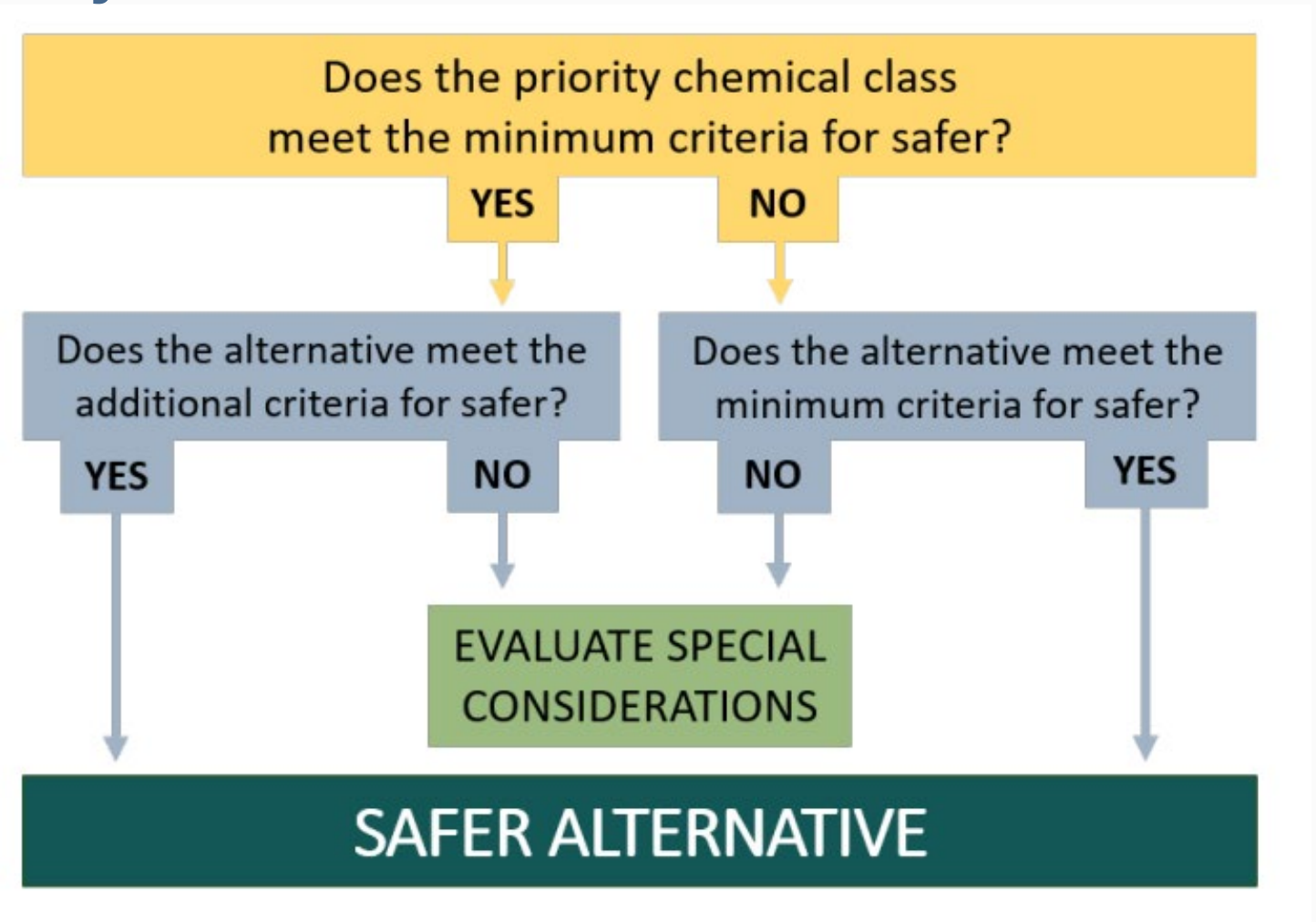
Hazard Criteria

- Specific data requirements and standards to assess chemical safety
- Ecology is currently developing the criteria for assessing 6PPD alternatives
- Alternative will require data on carcinogenicity, reproductive toxicity, mutagenicity, acute toxicity, and other parameters

Safer Products for Washington (SP-WA) 2022 Criteria Summary

Identifying chemicals that are Safer

- Safer is defined in the law as “less hazardous to humans or the environment than the existing chemical or process.”



Access slide 21 for detailed figure description.

SP-WA 2022 Criteria Summary

- Two main requirements
  - Chemical has data on required hazard endpoints
  - Data shows that the chemical aligns with GreenScreen® Benchmark 2 or better
- All known data will be used, even if it is outside the required endpoints
  - Includes data on breakdown products and exposure pathways

SP-WA 2022 Data Requirements

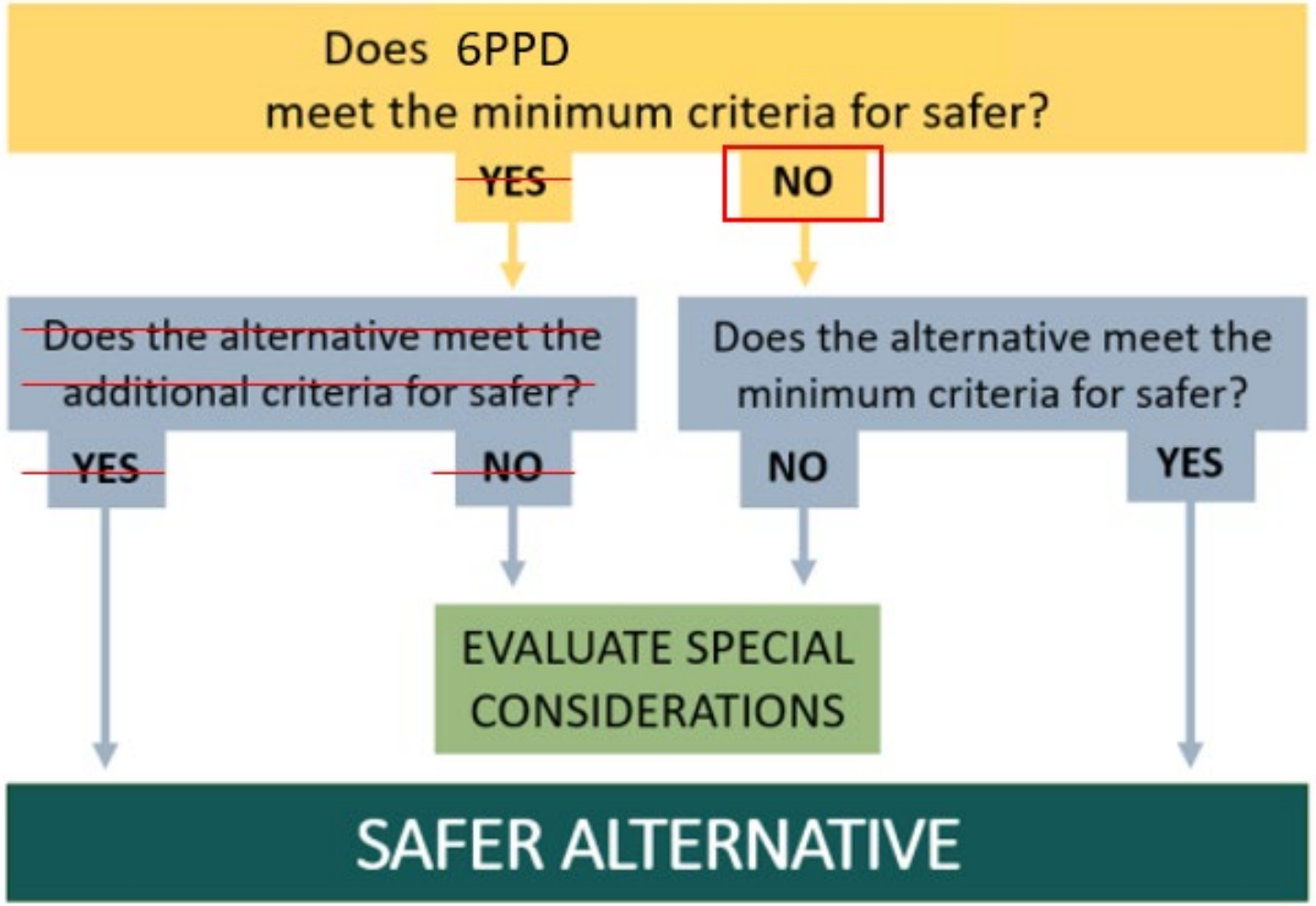
Hazard endpoint	Requirement
Carcinogenicity	Required
Mutagenicity/Genotoxicity	Required
Reproductive or Developmental Toxicity	Required
Endocrine Disruption	Not required
Acute Toxicity	Not always required*
Single or Repeat Systemic Toxicity	Not always required*
Single or Repeat Neurotoxicity	Not always required*

Hazard endpoint	Requirement
Skin or Respiratory Sensitization	Required
Skin or Eye Irritation	Not required
Acute or Chronic Aquatic Toxicity	Required
Persistence	Required
Bioaccumulation	Required

*Two of three required

Criteria for Safer- 6PPD

- 6PPD is a Benchmark 1 chemical
  - Avoid use: Chemical of High Concern
- Following Safer Products for Washington criteria with three additions



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Additions to SP-WA Criteria

Addition One

- Chemicals must have experimental data on acute aquatic toxicity to coho salmon as well as two other trophic levels
  - Any extra data will also be considered

Addition Two

- Data required on acute toxicity for transformation products when alternative is exposed to ozone

Additions to SP-WA Criteria (cont.)

Addition Three

- Strict LC_{50} values for acute aquatic toxicity
  - 6PPD-q toxicity to coho salmon is at ~0.1 ug/L
  - Alternatives (and transformation products) must have LC_{50} >0.1 mg/L

GreenScreen® acute aquatic toxicity LC_{50} values

Measurement	Very High	High	Moderate	Low
LC_{50} (mg/L)	<1	>1 to 10	>10 to 100	>100

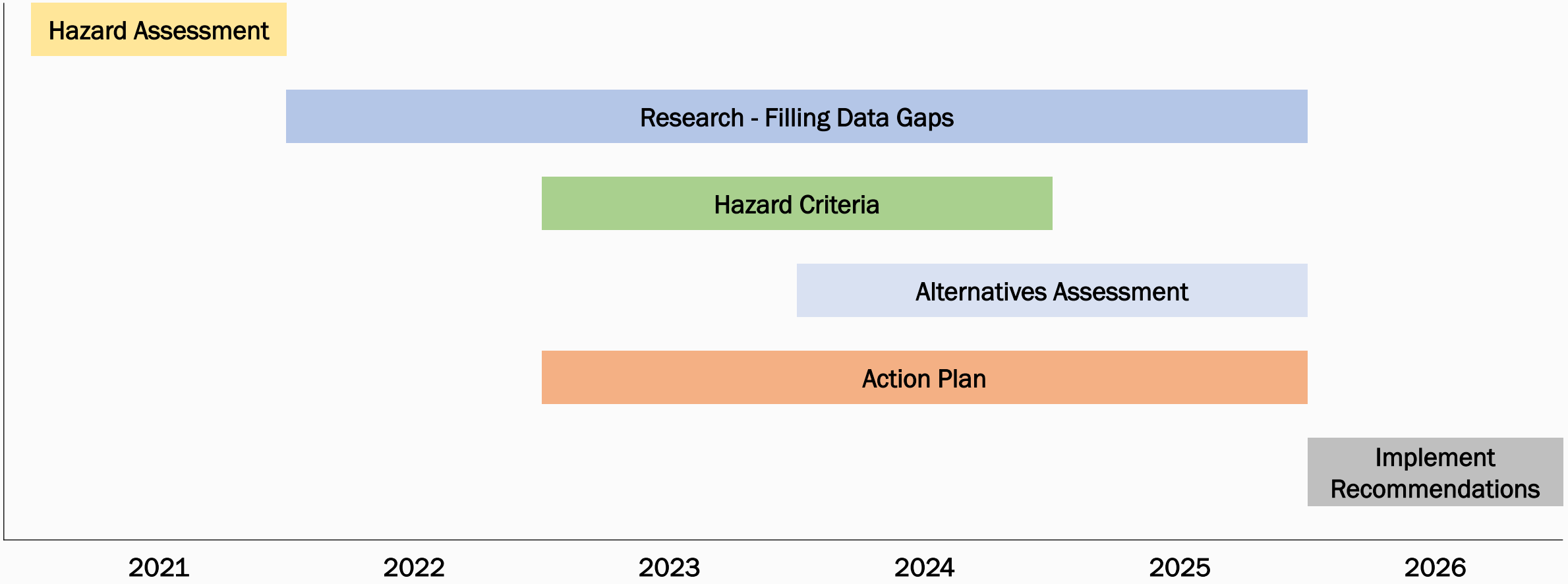
Alternatives Assessment

- Will begin once data gaps are filled in and hazard criteria is finalized
- Identify, compare, and select safer alternatives to 6PPD
    - Review requirements for toxicity, performance, feasibility, and availability
    - “If the department finds safer alternatives exist, include recommended regulatory, policy, or legislative actions to advance safer alternatives.”

6PPD Action Plan

- Problem review and Environmental Justice review
- Follow the public process and economic analysis of WAC 173-333
- Consider tire performance and safety
- Provide actionable recommendations, including regulatory, policy, or legislative
- Advisory Committee – Fall 2023

Estimated Timeline



Schedule dependent on legislative funding and progress/outcome of research.

Access slide 22 for detailed figure description.

Contact information

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For more information:

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Figure Descriptions

- **Slide 11:** When determining whether a chemical is safer, we first ask whether the priority chemical class meets the minimum criteria for safer. If yes, we then ask whether the alternative meets additional criteria for safer. If yes, it is considered a safer alternative. If no, we evaluate special considerations. If a priority chemical class does not meet the minimum criteria for safer, then we ask if an alternative meets the minimum criteria for safer. If yes, it's a safer alternative. If no, we evaluate special considerations.

- **Slide 14:** Because we know 6PPD does not meet the minimum criteria for safer, we are evaluating whether alternatives meet the minimum criteria. If yes, it's a safer alternative. If no, we will evaluate special considerations.

Figure Descriptions

- **Slide 19:** We completed an initial hazard assessment (discussed in previous slides) in 2021. Since then, we have been conducting and funding research to fill data gaps. In 2023, we began developing hazard criteria for use in an alternative assessment. We hope to begin work on the alternatives assessment mid-2023 to 2024 and complete the assessment by the end of 2025. We are also in the beginning stages of completing an action plan, which we aim to complete by the end of 2025. Any recommended actions, including regulatory, legislative, and policy related to source reduction, would occur in 2026 and beyond. You could visualize continuous arrows on most of these products, as research to understand fate and transport of 6PPD will continue well beyond the life cycle of the action plan, and we envision routinely updating information to make sure we are making the best decisions for the people of Washington State.