Whitepaper: Circular Solar Integrated Remediation System

A New Global Standard for Responsible Mining, Recycling, and Atmospheric Removal or Degradation

Subject: Photocatalytic Neutralization of Heavy Metals and PFAS real-life testing/utilizing atmospheric doping for TiO2-Dolomite Limestone, Nanostructures and Airborne capture system (fixed system and with drones) for Abatement of VOCs, NOx, SOx, Black Carbon, and Tire-Wear Microplastics, Toxins.

Whitepaper by Cherise Petker Founder/CEO CircularSolar.net created with the assistance of Grok and Gemini AI assessing R&D, applications with Tio2 photocatalyst began in 2002-2004, 2008-2020, 2020 – current plus all data on the internet.

Published March, 16th, 2026

---

1. Executive Summary

The **Circular Solar Remediation System** introduces a paradigm shift which includes a breakthrough from **"Pollution-Powered Remediation."** Traditional TiO2 photocatalysis is often limited by narrow light absorption and surface poisoning. Circular Solar's field results over years—validated at the intersection of **Radius Recycling** pollution and **Highway 880**—prove that industrial stressors like **Zinc (Zn), Lead (Pb), and Copper (Cu)** act real-life doping materials (atmospheric deposition) as a catalytic engine is implemented in our system, designs. This also scales to use around mine sites, e-waste facilities and more.

A system for remediation of Automobile Shredder Residue (ASR) Emissions, Responsible Mining, E-Waste processing and AI Power, Infrastructure Supporting NEPA Reform and the SPEED Act which is bipartisan (end uses improve solar-bess efficiency and can include recycled Wind turbine waste/recycling also pollution prevention or reduction in the event of wind, solar failure/debris and the system provides environmental remediation for fossil fuels; bipartisan). This verifiable infrastructure directly supports **NEPA reform** and the **SPEED Act** by providing the environmental safeguards required for fast-tracked permitting.

By integrating **Reactive Direct Air Capture (R-DAC)** misting systems and site-specific **Nanorocks** made from virgin and waste rock (and other method), the system achieves **80–98% degradation** of persistent toxins. This system represents the highest environmental standard for mining and recycling, providing a "Zero-Waste" solution that petrifies complex toxins like PFAS and cyanide into stable minerals while aggressively reducing environmental cancer risks, while we use “Zero Waste” materials (such as low value mine site waste rock to recycles aggregates.

Over the course of several years, starting in 2002, this project, applications were designed to meet Bipartisan agendas, projects, energy while ensuring America First principles. To re-shore mining, recycling, manufacturing into the U.S., which could happen with the help of this technology, real-life material science tests (doping with atmospheric deposition of metals/minerals) and creative applications which support all energy types (with a primary focus on solar-bess) and visual comparison results to prove Responsible Mining, Recycling, Power.

---

2. Mining & Recycling: Environmental Performance Mitigation Chart

Assessment made with AI tools Gemini, Grok and third party data online, including DTSC, BAAQMD reports, international reports and CS multi-year real-life comparison visuals, fast 2008 micro FOAK infrastructure in soil, plants, reports on this page and primary web pages: https://circularsolar.net/pfas%2C-toxins%3B-cancer

1. Active Source Control: Circular Solar’s TiO2 Photocatalyst Misting System

To intercept pollutants at the highest concentration at the source with water and TiO2 photocatalyst deployed via a misting system directly over the hammer mill and fence line areas at Automotive, metal shredder recycling, e-waste recycling mine sites and more.

The "Mist-as-a-Reactor" Effect

Unlike traditional water sprays that only suppress dust, the TiO2 mist creates a "reactive cloud."

- **Encapsulation:** Micro-droplets encapsulate metal dust and VOCs instantly upon emission.
- **In-Situ Doping Speed:** Airborne Cu and Zn particulates from the shredding process dissolve into the droplets, immediately doping the TiO2 and increasing its catalytic activity under ambient or LED light.

2. Estimated Dwell Time for 90% VOC Removal

The efficiency of photocatalytic degradation follows first-order kinetics (C = Co e -kt). For a 90% reduction in Volatile Organic Compounds (VOCs), the required "dwell time" (the time the mist remains airborne or in contact with the pollutant) is calculated as:

$$t_{90\%} = \frac{-\ln(0.1)}{k} \approx \frac{2.303}{k}$$

Rapid Reaction (k = 0.05 s -1): Required dwell time = **46** seconds.

- **Standard Reaction (k = 0.02 s -1):** Required dwell time = 115 seconds.
  With AI-optimized mist density and UV-LED integration, a target dwell time of **30–90 seconds** within the shredder housing can achieve near-total VOC and odor abatement.

Pollutant Class	**Estimated Removal (%)**	**Primary Mechanism**	**Environmental Impact**
PFAS (Long-Chain)	**80% – 98%**	Pb/Cu-Doped TiO2 Cleavage	Removal of "Forever Chemicals"
Tire Wear (6PPD)	**85% – 95%***	ZnO/TiO_2* Heterojunction	Salmonid & Aquatic Protection
Cyanide (CN^)	**90% – 99%**	Photocatalytic Oxidation	Neutralization of Mining Reagents
Inorganic Arsenic	**75% – 90%**	Photo-oxidation (As III to V)	**Cancer Risk Reduction**
Cadmium & Mercury	**65% – 85%**	Photocatalytic Deposition	Prevention of Bioaccumulation

Pollutant Class	Estimated Removal (%)	Primary Mechanism	Environmental Impact
Hexavalent Chromium	Photoreduction (Cr VI to Cr III)	Non-toxic, stable mineral (major improvement for PG&E and Waterboard if implemented).	
NOx / SOx	Radical Oxidation		Neutralized as harmless nitrates/sulfates.
Microplastics	Oxidative Degradation	Accelerated polymer chain breakdown.	Toxicants turned to Stone

*Potentially higher 98%+ with Jessika Petker's recommendation (to the mix) which she has suggested for decades.

---

3. Mining Site and Recycling Integration: The Zero-Waste Standard

3.1. Waste Rock "Nanorocks"

Mines generate vast quantities of overburden. Circular Solar crushes this **site-specific waste rock** and coats it with photocatalyst to create Nanorocks. If the waste rock is carbonate-rich (Dolomite), it becomes the ultimate **Mineralization Sink**, petrifying fluoride from PFAS and stabilizing arsenic/cadmium runoff into solid mineral forms.

3.2. Reducing Environmental Cancer Rates

Industrial sites often release a "toxic cocktail" of Class 1 carcinogens. Circular Solar aggressively reduces these loads:

- **Arsenic Mitigation:** Facilitates the photo-oxidation of Arsenite [As(III)] to Arsenate [As(V)], which is less mobile and sequestered by the Nanorock bed.
- **Mercury & Cadmium:** Uses photocatalytic deposition to reduce metal ions into stable, solid states, preventing inhalation as fugitive dust.
- **Community Health:** Lowering these carcinogens at the fence line directly moves the needle on the 21.6-per-million risk levels often seen in industrial corridors.

3.3. Permitting Reform: Reshoring American Mining,

The implementation of Circular Solar technology represents a critical breakthrough for **Permitting Reform**. By providing a verifiable, "Zero-Leakage" environmental shield, Circular Solar addresses the primary regulatory hurdles—water quality and air emissions—that often stall domestic mining projects for decades.

- **Accelerated Permitting:** With a system that mineralizes toxins in real-time, mines can meet "Best Available Control Technology" (BACT) standards more easily, giving regulators the confidence to fast-track permits.
- **Reshoring Critical Minerals:** By de-risking the environmental impact, Circular Solar enables the **reshoring of American mining** for gold, silver, and critical minerals (Lithium, Cobalt, Copper). This secures the domestic supply chain for the green energy transition.
- **The "Cleanest" Ores:** Minerals produced under this shield are the **cleanest gold, silver, and critical minerals** on the global market. They carry a "low-carbon, zero-toxin" pedigree, allowing mining companies to command a premium for responsibly sourced materials that protect both the climate and local communities.

3.4 Permitting Reform: Cleaner E-waste, Automobile Metal Shredder Recycling

The 2026 regulatory landscape, marked by **NEPA reforms** and **Clean Water Act Section 401 streamlining**, prioritizes "procedural certainty." Circular Solar provides the technical certainty required to meet these new standards:

- **Accelerated Permitting:** By providing a verifiable, containment shield (both airborne capture system and once deposited on sensitive areas; such as one example on concrete surfaces by storm drains), Circular Solar helps projects meet **Best Available Control Technology (BACT)** standards. This is may be seen as a bridging the gap between California's **SB 811 (2026)** **and** **SB 404** a bill which would have dangerously weakened hazardous waste protections for public health and the environment from California’s most toxic polluters, metal shredding facilities.

- **Retaining and reshoring Critical Minerals:** By de-risking the environmental impact of domestic extraction, Circular Solar enables the reshoring of American mining for gold, silver, and critical minerals.
- **The "Cleanest" recycled materials, such as steel, e-waste content:** Recycled minerals and metals produced under these higher environmental and health standards, **cleanest on the global market**, carrying a low or "zero-toxin" pedigree that allows mining, recycling companies and manufacturers can ensure their products are responsibly sourced materials to meet domestic or export market standards, such as in the EU for its future Circular Economy Act (EU) and low-carbon standards.
- **NEPA Reform and the SPEED Act** to bridge the gap between industrial necessity and environmental protection to support the U.S. winning the AI race.
- **NEPA Reform:** By mitigating airborne toxins at the source, the facility significantly reduces its "Environmental Impact Zone." This allows for faster NEPA reviews by demonstrating that the project will not lead to significant soil or groundwater degradation.
- **The SPEED Act:** This act seeks to accelerate the "critical mineral" supply chain. By using CS misting and Nanorocks, a recycler like Radius Recycling can prove it is a "Responsible Miner" of secondary materials, satisfying the environmental criteria for expedited federal support and permitting.
- **Soil and Groundwater Protection:** The settled TiO2 slurry and Nanorock perimeter prevent the leaching of "forever chemicals" and carcinogenic toxins into the groundwater commons, preserving the health of the surrounding community, our process also scales to UN Zero Waste initiatives and can include post war rubble to Nanorocks (for solar efficiency) and more.

---

4. Infrastructure & low-tech Direct Air Capture (DAC)

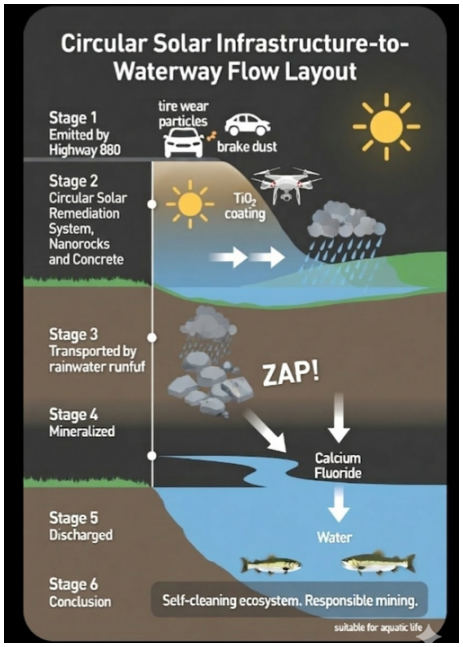
- **Reactive DAC (R-DAC)*:** The misting system acts as a version of Direct Air Capture that **destroys** airborne toxins using ambient solar energy and industrial heat.
- **Stormwater Quality:** Infrastructure coatings capture **6PPD, 6PPD-quinone** from Highway 880. Runoff filtered through Nanorock beds (and other method) ensures stormwater is safe for **Coho Salmon** and **Steelhead Trout**.

The system, prototyped on testbed OCTOPUS, videos, description are available to stakeholder and investors.

5. Infrastructure-to-Waterway Flow Layout & Real-life Pollution Buildup and Remediation study, Cost/Value Assessment Example for Radius Recycling

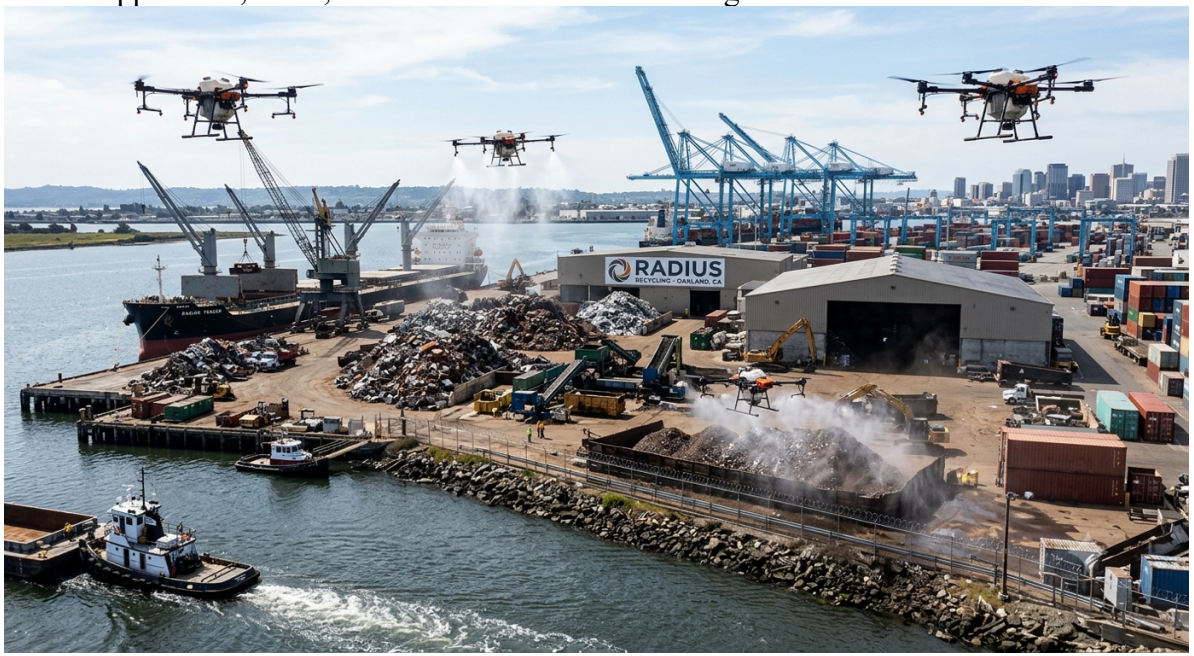
The following diagram illustrates the lifecycle of a pollutant—from a tire on Highway 880 to its final "petrified" state in the rock bed:

1. **Emission:** Tire wear particles (6PPD) and brake dust (Cu/Zn) are released onto treated road surfaces.
2. **Activation:** Sunlight activates the TiO2 infrastructure coating; the heavy metal dust self-dopes the surface, increasing its efficiency.
3. **Transport:** Rainwater washes the partially degraded pollutants into the **Circular Solar Rock Bed** (60/40 Nanorock/Dolomite mix).
4. **Final Scrub:** The high surface area of the rocks provides a final catalytic "zap."
5. **Mineralization:** Fluoride ions from PFAS are captured by the Dolomite, forming stable **Calcium Fluoride (CaF2)**.
6. **Discharge:** Safer, cleaner, mineral-balanced water enters waterways for supporting salmon and trout health (6PPD tire wear microplastic has decimated fish populations).



Net Value Creation Site Example: Radius Recycling Oakland, CA

Circular Solar Remediation System Drones:
Dust suppression, VOC, toxin remediation and reducing fire risks



- Initial Capex: $2.5 million
- Annual Opex: $500,000

Amortized annually over 5–10 years (10–12-year system durability), total annual CS-RS cost ≈ $750k–$1.0M (mid-point $875k for net calculations below). Net annual benefits remain highly compelling: $10.4M–$32.7M after deducting all costs — driven by avoided regulatory escalation, fines, shutdown/relocation risk. Payback on $2.5M capex in <9 months at mid-range avoided costs, with post-payback ROI of 10–30×+ annually. Quantitative Assessment: As-Is Costs vs. CS-RS Benefits (Gross & Net) Estimates attribute ~20–30% of local burdens to Radius (based on NOV/fine history, fire incidents, stormwater contributions). Human, environmental, business costs use conservative sources (BAAQMD WOCAP, EPA pre-2026 frameworks, SFEI PFAS studies, soil sampling).

Impact Category	As-Is Annual Burden (Radius-Attributable) Human + Environment + Business	CS-RS Interventions & Avg. Reduction	Gross Annual Avoided Costs / Benefits	CS-RS Annual Deployment Cost (amortized)	Net Annual Benefit (after CS costs)	Rationale & Key Data Sources
Air Health (Asthma, CVD, cancer, respiratory)	$2.5M–$6M (Elevated asthma ED/hospitalizations 76–88% above county; heart deaths 33% higher; fire spikes)	Misting (fixed/drone): 80–95% PM/VOC/black carbon capture TiO2 surfaces: dust reduction	$1.9M–$5.4M (70–90% avoided)	–	$1.9M–$5.4M	BAAQMD WOCAP: 62% asthma drop post-reductions; ED visits ~$5k–$10k/case; school absenteeism 40%+ higher
Soil/Gardens (Lead/metal uptake in produce)	$0.8M–$2.5M (Soil Pb 314–573 mg/kg avg; neurodevelopmental risks)	Nanorocks: 75–90% mineralization TiO2 surfaces: prevents wash-off	$0.6M–$2.2M (75–90% reduced)	–	$0.6M–$2.2M	West Oakland soil studies; CA lead productivity losses; urban ag ingestion risks
Bay/Seafood (PFAS, 6PPD-quinone, metals/microplastics)	$0.7M–$2M (83% fish unsafe daily; subsistence angler risks; salmon toxicity)	Nanorocks stormwater: 80–98% removal TiO2 + misting: blocks runoff	$0.5M–$1.8M (70–90% reduced loading)	–	$0.5M–$1.8M	SFEI PFAS studies; Bay advisories; ecosystem/fisheries impacts
Regulatory, Fines & Fire (NOVs, suits, cleanup)	$0.5M–$2.5M ($575k recent fine; pending civil lawsuit; EPA orders)	Full suite: source compliance + smoke capture	$0.4M–$2.2M (80%+ avoidance)	–	$0.4M–$2.2M	Radius NOV history; BAAQMD/EPA actions; 2025 lawsuit ongoing
Permit Revocation / Shutdown / Relocation Risk (CA → NV)	$10M–$25M (Risk-adjusted exposure; potential one-time relocation/downtime costs $100M–$250M+ for mega-shredder move, lost strategic deep water port access, permitting/revenue disruption)	Full CS-RS suite: compliance documentation, 80–98% emission/mineralization reductions, fire mitigation proof to retain permits	$8M–$22M (80%+ risk reduction)	–	$8M–$22M	Pending 2025 civil lawsuit/injunction risk, recurrent fires/NOVs, DTSC/BAAQMD enforcement; strategic CA port value
CS-RS Deployment & Ongoing Costs (2.5M capex amortized + 500k/yr opex;	N/A	Full suite	N/A	$750k–$1.0M (mid: $875k)	–$750k–$1.0M	Your provided figures (internal scaling for industrial site)
TOTAL	$14.5M–$38M	CS-RS Suite	$11.4M–$33.6M	$750k–$1.0M	$10.4M–$32.7M	Conservative; payback on $2.5M capex in <3–9 months; 10–30×+ annual ROI post-payback.

Net Value Creation:

- Low-end net: $10.4 million annual savings after all costs.
- High-end net: $32.7 million annual savings.
- Payback period on $2.5M capex: 3–9 months (conservative low-end avoided costs cover it quickly).
- Post-payback ROI: 10–30×+ annually, with the permit/shutdown category providing the largest lever.
- Upside: Grants (People's Air $400k, AB 617) could offset 15–40% of capex → even faster payback. Pilot validation of 90%+ reductions would further increase net benefits.

Implementation Pathway for Radius Trial:

- Phase 1: Targeted pilot (e.g., priority shredder/stockpile misting + 20–30k sq ft TiO2 coating + Nanorocks stormwater beds) to demonstrate reductions and cost efficiencies.
- Phase 2: Scale to full 100,000+ sq ft, integrate drones/water trucks, expand fixed misting.
- Benefits: Provides compliance evidence to support permit retention, reduces NOV/fire risks, enhances community/ESG standing.
- Funding: People's Air Grant ($400k), AB 617, Seed Capital, or Toyota Tsusho (which purchased RR: new owners liability).

5. Ideally as low as 2.5M capex + $500k annual opex with CS-RS generates $10.4M–$32.7M net annual value — a compelling case for trial, especially amid ongoing enforcement (2025 lawsuit, 2026 fire investigation). The system directly mitigates the pathways driving violations while delivering health, Bay protection, and business continuity wins.

References (abridged; updated March 2026): BAAQMD NOVs/community notices (incl. March 2026 fire), 2025 civil lawsuit/press releases, $575k 2024 fine, WOCAP reports, SFEI PFAS data, West Oakland soil studies, Radius enforcement history.

6. The 2026 SPEED Act Convergence & Multi-Vector Energy Breakthrough

1.0 Executive Summary of Breakthrough Status

The Circular Solar Integrated Remediation System (CS-RS) represents a structural breakthrough for the **Standardizing Permitting and Expediting Economic Development (SPEED) Act of 2026**. By solving the land-use, waste, and pollution-deposition bottlenecks that traditionally delay energy projects, the CS-RS enables a "Fast-Path" for both renewable and fossil fuel infrastructure.

2.0 High-Density Energy & AI Infrastructure

Traditional solar infrastructure is land-intensive, often triggering lengthy NEPA reviews due to its footprint.

- **Ultra-High Density (CS SAT, DAT, & Vertical Farms):** The CS-RS utilizes vertical agrivoltaic and bifacial tracking (SAT/DAT) configurations to achieve the industry's **highest energy density per ground-mounted acre**.
- **Micro-Data Center Synergy:** By co-locating AI micro-compute with high-density BESS-integrated solar, the system bypasses grid-interconnection queues, delivering immediate 24/7 power-compute "Alpha Assets" on parcels as small as 3.8 acres.

3.0 Fossil Fuel & Natural Gas Remediation

A unique breakthrough of the CS-RS is its ability to neutralize the externalities of traditional fossil fuel energy.

- **Atmospheric Deposition Degradation:** CS Nanorocks and coated infrastructure utilize active photocatalytic surfaces to degrade a high percentage of NOx, SOx, and particulate matter deposited from nearby combustion sources.
- **Permitting Neutralization:** For natural gas plants being fast-tracked under the SPEED Act, the integration of CS-RS surfaces provides an "active environmental filter" that mitigates local air quality impacts, significantly reducing the 150-day litigation risk profile.

4.0 Thermal Management & UHI Mitigation

The 2026 climate landscape mandates aggressive **Urban Heat Island (UHI)** reduction.

- **Passive Cooling (Nanorocks):** Our recycled composite Nanorocks provide high-albedo surfaces for exterior building envelopes and road infrastructure, passively reducing ambient temperatures.
- **The Water-Energy Nexus:** By reducing the thermal load of the built environment, the CS-RS directly lowers the evaporation rates and water demand for cooling systems in data centers and power plants, a critical requirement for California permitting.

5.0 Proven 12-Year Durability Lifecycle

The CS-RS is backed by real-world longitudinal data from our **2008 FOAK Infrastructure Project in California**.

- **Long-Term Performance:** Testing has confirmed that the active photocatalyst layers maintain efficacy for **over 10–12 years**, requiring reapplication only once per decade.
- **O&M Transformation:** This durability shifts environmental remediation from an "ongoing operational expense" to a "durable capital asset," aligning with 10-year infrastructure bond cycles and federal "Made in America" resource mandates.

6. Conclusion

The Circular Solar system proves that the most toxic industrial sites can be turned into self-cleaning ecosystems. By utilizing "toxic" zinc, lead, and copper from metal shredding (or mine site) as atmospheric doping improves Tio2 Photocatalyst rates to power the destruction of PFAS, cyanide, and arsenic. We provide a holistic, scalable solution that protects human health, lowers cancer rates, and secures the future of domestic, responsible mining, recycling and more.

Whitepaper and real-life results created by Cherise Petker, CEO/Founder, CircularSolar.net.

Acknowledgements & In Memoriam

This breakthrough would not have been possible without the tireless dedication of my past Co-Founder, **Mr. George Petker**, Founder of Versatech Capital For Mining (dba Petker.com).

George dedicated decades to the mining industry across the U.S., Canada, and Mexico—often through selfless, unpaid work—to drive operational efficiency and reduce costs. His efforts were instrumental in helping domestic producers compete globally, re-shoring critical mineral production, and unlocking U.S. manufacturing potential. His early surveys for the Circular Solar project were vital in helping us to establish a pathway for responsible mining and supply-chain security.

We are forever grateful for his sacrifices, his profound knowledge and support.

Underground high-grade copper-silver mine, Eastern Nevada, 2020, video.