Foreword

My name is **Vir Gogia** (hereafter referred to as "the Author"), and this handbook is the result of over a year of research, experimentation, and reflection on the problem of construction-related air pollution in Mumbai. Growing up in a city that consistently records some of the highest particulate levels in the world, I witnessed first-hand the health burdens that dust and nanoparticle emissions place on families, workers, and neighbourhoods. These experiences formed the starting point for my sustained academic and technical inquiry.

My journey began with a strong interest in environmental science and data-driven solutions, which eventually led to the creation of a portable monitoring device called *NanoWatch*. The device was designed to measure and characterise airborne nanoparticles in real time. I tested it in construction sites across Mumbai. The data confirmed what many communities had long suspected: that construction activity is not simply a local inconvenience but one of the city's most significant contributors to particulate pollution, particularly in densely populated neighbourhoods.

Through building and refining NanoWatch, I came to understand the intersection of science, engineering, and public health. I learned how particles behave, how to conduct site-based trials, and how to translate sensor outputs into insights that could be acted upon by both experts and everyday citizens. Along the way, I also realised that communities and developers lacked accessible, detailed guidance on protecting themselves from pollution and managing pollution levels, respectively.

This handbook is an attempt to close that gap. It brings together three strands:

1. Technical evidence from my own measurements and broader scientific literature.
2. First-hand observations from Mumbai's construction environments.
3. International best practices adapted to the Indian context.

Its purpose is straightforward: to provide both neighbourhood residents and builders with a clear, practical reference that can be used daily, not just stored away in compliance files.

At its core, this work is driven by a belief that construction and development need not come at the expense of public health. With clear standards, effective enforcement, and community awareness, Mumbai can continue to grow while keeping its air safer to breathe.

Contents

Chapter 1

Executive Summary

1.1 Why this handbook, key objectives, top 10 actions

This handbook translates health science, Indian regulations, and Mumbai-specific directions into a practical, auditable playbook for controlling particulate pollution (PM_{10}, $PM_{2.5}$, and ultrafine nanoparticles) at and around construction sites. It is written for developers, PMCs/EHS leads, site engineers, and subcontractors, and is designed to be inserted directly into contracts, method statements, and daily site routines.

Objectives

1. Prevent and reduce airborne particulate emissions at source across all construction phases.
2. Protect workers (task-based exposure control) and neighbours (ambient downwind control).
3. Provide a monitoring–action framework with clear thresholds and stop–work criteria.
4. Standardise documentation for audits, tenders, and community transparency.

Top 10 Actions (Quick Reference)

1. Install upwind/downwind PM monitors; define alert, escalate, stop–work, and resume thresholds.
2. Enforce wheel–wash at exits; stabilise/pave haul routes; cap site speed at 10–15 km/h.
3. Cover and crust stockpiles; add wind–break fencing; prevent track–out onto public roads.
4. Ban dry cutting/grinding; mandate wet cutting with LEV and HEPA vacuums.
5. Deploy misting/fog systems with suitable droplet sizes; manage runoff and slip hazards.

6. Enclose high–dust activities; use negative–pressure booths with HEPA extraction where feasible.

7. Sequence work; avoid concurrent high–dust tasks; use favourable wind/weather windows.

8. Electrify where practicable; limit idling; maintain engines to emissions standards.

9. Run a respiratory protection programme (N95/P100) with fit testing and toolbox talks.

10. Keep transparent logs; perform weekly EHS audits; share a public site summary.

1.2 Quick-reference responsibilities (Developer / Contractor / Subcontractor)

Developer/Owner: Set minimum standards and fund controls; approve the Dust Mitigation Plan (DMP); require monitoring and stop–work protocols in contracts; commission third–party audits.

PMC/EHS: Translate standards into site SOPs; run training and toolbox talks; verify monitoring data quality; lead investigations and corrective actions; report to authorities and community.

Main Contractor: Implement the DMP and SOPs; operate and maintain equipment (wheel–wash, misting, enclosures); keep logs; control subcontractors; stop work when thresholds are exceeded.

Subcontractors: Follow method statements; maintain housekeeping; use PPE; attend training; log activities and issues; escalate deviations immediately.

Chapter 2

Context & Health Rationale

2.1 Health risks of PM10, PM2.5, ultrafine nanoparticles

PM size and health pathways. PM_{10} (aerodynamic diameter $\leq 10\,\mu$m) deposits in the upper airways, irritating mucosa and aggravating asthma and bronchitis. $PM_{2.5}$ ($\leq 2.5\,\mu$m) reaches the alveoli, triggering inflammation, reduced lung function, cardiovascular stress, and elevated mortality risk. Ultrafine nanoparticles ($\leq 0.1\,\mu$m) have high surface area, can translocate into the bloodstream, and are implicated in systemic inflammation, cardiovascular disease, and possible neurodegenerative pathways.

Occupational exposure. Task-based construction exposures (for example dry cutting of concrete or masonry) can exceed ambient levels by orders of magnitude, especially for respirable crystalline silica (RCS). Without wet methods, LEV, and PPE, workers face risks of silicosis, COPD, and lung cancer.

Community exposure. In dense Mumbai neighbourhoods, construction often coexists with schools, housing, hospitals, and markets. Elevated particulate levels increase asthma exacerbations, hospital visits, absenteeism, and long-term cardiopulmonary burden, with children and the elderly most affected.

Ethical rationale. Beyond legal compliance, developers have a duty of care to workers and neighbours. Dust control is integral to ESG claims and brand credibility for premium developments.

2.2 Typical emission sources at construction sites

- **Excavation and earthworks:** soil disturbance and loading create coarse PM_{10} plumes, especially in dry or windy conditions.
- **Demolition:** mixed mineral dust (cement, gypsum, paint residues); high RCS risk when breaking concrete or masonry.
- **Cutting, grinding, drilling:** fine abrasive dust ($PM_{2.5}$ and smaller); RCS dominant in concrete and stone; dry methods are unacceptable.

- **Concreting and cement handling:** cement or fly ash fines; secondary aerosols from additives and curing processes.
- **Stockpiles and transfer points:** wind erosion and material drops; prevent with covers, moisture control, and enclosures.
- **Haul roads and logistics:** resuspension from vehicle movement; track–out onto public roads without wheel–wash.
- **Diesel plant and gensets:** ultrafine soot or black carbon and NO_x; mitigate via maintenance, electrification, and siting.

Chapter 3

Regulatory Landscape (Mumbai & India)

3.1 Summary of applicable rules and municipal directions

National (India). The CPCB National Ambient Air Quality Standards (NAAQS, 2009) set ambient limits for $PM_{2.5}$ (annual 40 μg/m^3, 24 h 60 μg/m^3) and PM_{10} (annual 60 μg/m^3, 24 h 100 μg/m^3). The Construction & Demolition (C&D) Waste Management Rules (2016, with updates) mandate dust suppression, covering or containment, wheel–wash, authorised transport and disposal, and documentation (DMP, manifests, weighbridge slips).

State (Maharashtra). MPCB enforces the Air Act consents and conducts joint inspections with municipal bodies. Circulars emphasise wheel–wash, paved or stabilised haul routes, regular road cleaning, and daily housekeeping.

City (Mumbai/BMC). BMC guidelines require perimeter sheeting (often 35 ft for large sites), enclosure of high–dust work, misting or sprinkling, stockpile covering, and functioning wheel–wash at exits. Recent mandates require real–time PM monitoring (approved devices), perimeter LED display of live values, and streaming of data to BMC servers. Active enforcement includes show–cause notices, penalties, and work stoppage for persistent non-compliance.

3.2 Compliance matrix (who, what, when)

Topic	Requirement	Responsibility	Evidence/When
Perimeter enclosures	Tin/metal sheets (often 35 ft for large sites); dust screens; enclose high–dust tasks	Main Contractor; verified by PMC/EHS	Layout drawings, dated photos; weekly audit
Wet suppression	Routine misting/sprinkling; anti-smog guns; wet cutting only	Subcontractors with EHS oversight	Daily water or run-time logs; method statements; daily
Wheel–wash & haul routes	Wheel or tyre wash at exits; paved or stabilised routes; site speed 10–15 km/h	Logistics team	O&M logs; CCTV stills; road-cleaning register; daily
Stockpiles & transport	Cover, crust, and moisten stockpiles; cover trucks with tarpaulins	Materials manager	Stockpile register; cover photos; challans; daily
Real-time monitoring	Approved $PM_{2.5}/PM_{10}$ sensors; LED display; stream data to BMC	Developer/PMC/EHS	Device certificates; calibration and zero logs; API link; continuous
Ambient compliance	Use upwind/downwind logic; define alert, escalation, stop–work, and resume criteria	PMC/EHS lead	Threshold SOP; exceedance RCA; closure report; per event
C&D waste	Segregate; covered storage; authorised disposal	Contractor + vendor	Weighbridge slips; transporter authorisation; weekly
Records & training	Daily logs, audits, toolbox talks, PPE fit-tests; corrective actions	All site teams	Signed registers; audit checklists; CAP tracker; weekly

Table 3.1: Who does what, and what proof is required for audits and inspections.

Part I

Neighbourhoods: Living Safely Near Construction Sites

Chapter 4

Understanding Construction Dust & Nanoparticles

What kinds of particles come from construction?

Based on the author's research, data collection on active sites, and published studies on Indian construction environments, construction work produces different types of particles, some visible and some invisible. Knowing what they are helps communities understand why protection is important.

- **Silica dust (from concrete and stone):** Cutting or breaking concrete, tiles, or bricks releases very fine silica dust that can travel deep into the lungs. *Impact:* Can cause long-term breathing problems like asthma attacks or lung scarring if exposure continues.
- **Cement dust:** Handling cement bags, mixing with water, or pouring concrete creates fine grey powder. *Impact:* Irritates the eyes, throat, and nose; can aggravate asthma.
- **Plaster and gypsum dust:** Used for wall finishes and sanding. *Impact:* Can worsen allergies, causing sneezing, runny nose, or eye irritation.
- **Diesel smoke (black exhaust):** Generators, trucks, and machines running on diesel give out very small particles ("soot"). *Impact:* Linked to heart problems, strokes, and poor child development; pregnant women and elderly people are especially vulnerable.
- **Road dust:** Trucks moving in and out of sites drag soil and sand onto the road, which gets kicked up by traffic. *Impact:* Causes coughing and eye irritation; worsens asthma in children and the elderly.
- **Seasonal effects:** In dry summer, winds spread dust faster. During monsoon, rain reduces dust outdoors but damp particles can linger indoors. Near the sea, salty air makes dust stay suspended longer.

Chapter 5

Daily Household Precautions

Introduction

This guidance is based on the author's research and field data collection in Mumbai neighbourhoods affected by nearby construction. It sets out specific, practical steps for households to follow in order to minimise exposure to dust and nanoparticles.

1. When are peak dust hours?

Most dust from construction and traffic peaks at predictable times:

- Weekdays: 08:00–11:00 (morning deliveries, heavy work) and 15:30–19:30 (afternoon tasks, return traffic).
- Saturdays: often similar to weekdays.
- Dry season (Mar–May, Oct–Dec): overall dustier; winds lift road and stockpile dust.
- Monsoon (Jun–Sep): outdoor dust reduced, but damp particles linger indoors.

2. Daily routine: before, during, after peaks

Before (30–60 minutes): seal door/window gaps (door sweeps, damp towel, painter's tape), prepare 1–2 clean rooms, start air purifiers (HEPA H13/H14, CADR = room volume × 5 ACH), set ACs to recirculation.
During peaks: windows closed, avoid dry sweeping/dusting, no balcony shaking of rugs, keep purifiers on medium–high, masks (N95/P2) for sensitive people moving around common areas.
After peaks: 2–5 minutes cross-ventilation if outdoor air is cleaner, damp mop floors, damp-wipe surfaces, rinse balconies and window grills, launder reusable masks.

3. Room-by-room checklist

- **Bedrooms:** door sweeps, purifier sized to volume, clean bedding weekly, damp-wipe headboards.

- **Living room:** keep balcony doors shut, coir/rubber door mats inside and outside entrance, clean daily.
- **Kitchen:** chimney in recirc mode with clean filter, store powders sealed.
- **Bathrooms:** close exhaust flaps during peaks, toilet lid down before flushing.
- **Balconies/Windows:** wet-wipe rails, hang damp cotton curtain facing site, wash every 2–3 days.

4. Air purifiers and DIY options

Commercial: HEPA H13/H14 or True HEPA, CADR = room volume × 5 ACH, avoid ionizer-only devices.
DIY: Corsi–Rosenthal Box (fan + 4 MERV-13/14 filters), single-filter hack (fan + 1 HEPA filter panel). Replace filters every 3–6 months.

5. Masks

N95/P2/P3 masks with tight seal; child-sized certified masks for children. Wear outdoors during peaks, near sites, or when cleaning dusty areas. Replace disposable N95 after 1 week of intermittent use or when soiled.

6. Laundry and furnishings

Dry clothes indoors during peaks; wash curtains weekly in dusty months; vacuum cushions/sofas with HEPA vacuum or damp-wipe leather surfaces.

7. Simple monitoring

No gadget: keep a dust diary noting visible dust, diesel smell, site activity, health symptoms.
Low-cost sensors: basic $PM_{2.5}$/PM_{10} sensors in window; act if indoor $PM_{2.5}$ >35 $\mu g/m^3$ for 15 minutes.

8. Sensitive groups

Children: indoor play during peaks; schools should close windows during demolition/cutting.
Elderly/heart-lung disease: keep meds handy, move to clean room with purifier, seek medical help if breathless.
Pregnant women: avoid roadside walking near sites, indoor exercise, wear N95 if outdoors in peaks.
Asthma/COPD: follow action plan, keep reliever inhaler handy.

9. Society-level actions

RWAs should demand 24-hour notice for demolition/cutting, misting during high-dust tasks, wheel-wash for outbound trucks, public display or link to site PM dashboard, and WhatsApp alert groups for dust spikes.

Chapter 6

Precautions in Schools & Hospitals

Introduction

Schools and hospitals are high-sensitivity zones in dense neighbourhoods. Children, patients, and elderly are more vulnerable to dust and nanoparticles, and these institutions are often very close to active construction. The following measures are based on the author's field data and community research.

1. Schools

Building & classrooms:

- Seal windows/doors during peak hours (08:00–11:00, 15:30–19:30) with rubber seals, foam strips, or temporary tape.
- Use curtains/blinds; damp cotton curtains can act as dust catchers (wash weekly).
- Install air purifiers (CADR = room volume × 5 ACH), prioritising nursery, primary, and special needs rooms.
- Keep ceiling fans on low to circulate filtered air without drawing outside dust.

Timetable:

- Shift sports/assemblies indoors during dust-heavy hours.
- Schedule outdoor activities before 08:00 or after 19:30 when feasible.

Student health:

- Maintain an asthma registry; store spare inhalers with the nurse.
- Provide child-size N95 masks for susceptible students; keep extras in the office.
- Encourage hydration and a short lesson each term on dust and protection.

Admin protocols:

- Coordinate with contractors for advance notice of demolition or heavy cutting.
- Display a simple traffic-light PM board (Green <50, Orange 50–100, Red >100 μg/m^3 if readings available).
- Message parents via SMS/WhatsApp during spikes.

2. Hospitals and Clinics

Indoor air:

- Upgrade to MERV-13+ filters or deploy portable HEPA purifiers in waiting rooms/wards/ICUs.
- Maintain negative pressure in isolation wards and positive pressure in OTs.
- Seal windows/vents facing the site with plastic sheeting or temporary sealant during peak work.
- Use double-door entries where feasible to limit direct dust ingress.

Operations:

- Ensure emergency readiness: inhalers, nebulisers, oxygen; train staff to recognise dust-triggered asthma.
- Avoid outdoor patient transfers during peak hours.
- Cover ambulance bays or extend roofing to reduce direct dust entry.

Community engagement:

- Log spikes and formally request suppression from the site when needed.
- Share local air quality readings with nearby societies for awareness.

Chapter 7

Emergency Protocols for Neighbourhoods

Introduction

Sudden dust spikes can occur from unannounced demolition, high winds, or equipment failures. Neighbourhoods need clear, fast actions to reduce exposure and coordinate with construction sites.

1. Community alert systems

- Create a WhatsApp/Telegram "Dust Alert Group" with RWA, school, and clinic representatives.
- Use a standard alert: *" Dust Alert: Demolition at [Site], [Time]. Keep windows shut, stay indoors, masks outdoors, purifiers ON."*
- If possible, set low-cost sensors to trigger SMS/email alerts above 100 $\mu g/m^3$ $PM_{2.5}$.
- Assign 2–3 resident monitors to coordinate with site staff and broadcast updates.

2. Immediate household actions (first 5 minutes)

- Shut all windows/doors; place towels/door sweeps at gaps.
- Switch air purifiers to high in clean rooms.
- Wear N95 masks indoors if visible dust or diesel smell is present.
- Use a damp cloth over nose/mouth as fallback if masks are unavailable.
- Move children/elderly/patients into the cleanest room.

3. Community-level responses

- RWAs: call the contractor's site manager; request immediate misting and wheel-wash; if unsafe, demand temporary work stoppage.
- Security: stop outdoor play; guide residents indoors.
- Schools: halt outdoor classes; seal classrooms.
- Hospitals: switch patient intake routes to less exposed entrances.

4. After the event

- Brief cross-ventilation (2–5 minutes) once outdoor dust subsides.
- Wet mop/wipe common areas (avoid dry sweeping).
- Log incident (time, source, duration, complaints, photos).
- Escalate to BMC for repeated violations.

Part II

Construction Sites: Dust & Nanoparticle Mitigation

Chapter 8

Perimeter Enclosures & Barriers

8.1 Purpose

Perimeter enclosures form the first line of defence against dust leaving a construction site. They prevent the spread of coarse PM_{10} and finer $PM_{2.5}$ particles, reduce visual nuisance, and signal to nearby communities that the developer is actively protecting neighbourhood air quality. A strong, well-maintained barrier demonstrates both regulatory compliance and social responsibility.

8.2 Design Standards

Height Requirements

- Small/medium sites (plots <2,000 m^2): minimum 3.5 m (≈12 ft).
- Large/multi-tower or excavation projects: minimum 10 m (≈35 ft) as per BMC directives.
- Demolition sites: consider 12–15 m, especially if close to schools or hospitals.

Materials

- Corrugated tin/metal sheets mounted on steel frames are standard.
- Panels should overlap to avoid gaps.
- Frames anchored with concrete footings to withstand monsoon winds.

Sealing Gaps

- Ground-level gaps sealed using sandbags, rubber skirts, or continuous concrete plinths.
- No visible holes or cracks between panels.

Dust Netting and Mesh

- Add geotextile dust nets above the barrier to catch finer airborne particles.
- Nets must be UV-resistant and replaced annually.

8.3 Gates and Openings

- Gates should be double-leaf, self-closing, with minimal gaps.
- Entry/exit points designed as "airlocks": one gate closes before the other opens.
- Wheel-wash stations should be directly linked to these gates.
- Guards must ensure trucks do not leave with open tarpaulins.

8.4 Installation Best Practices

- Foundations: minimum 0.5 m deep concrete base to prevent collapse.
- Reinforcement: use cross-bracing in windy areas.
- Reflective safety strips painted at 1 m intervals for night visibility.
- No storage of debris against the inside of barriers (creates leakage risk).

8.5 Maintenance and Inspection

Daily:

- Walk-around inspection of panels and gates.
- Ensure no gaps or holes.

Weekly:

- Record findings in the Barrier Inspection Logbook.
- Replace damaged sheets or torn netting within 48 hours.

Quarterly:

- Repaint reflective strips.
- Tighten bolts and bracing before monsoon season.

8.6 Advanced Options

- Acoustic curtains to reduce both dust and noise for sensitive neighbours.
- Vegetative barriers: fast-growing trees (ashoka, ficus, bamboo) planted inside boundary as a living filter.
- Modular panels: prefabricated systems that can be quickly relocated as site stages shift.

8.7 Records and Compliance

- **Barrier Installation Drawing:** site plan showing alignment and gate placement.
- **Barrier Maintenance Logbook:** daily and weekly inspection entries with supervisor sign-off.
- **Photo Documentation:** date-stamped images of barriers from all sides at start of project, then monthly.
- **Audit Checklist:** used to confirm compliance with BMC requirements.

8.8 Community Interface

Perimeter barriers should display:

- Developer name and project details.
- Dust control notice: "This barrier is designed to reduce dust pollution. For concerns, contact [EHS number]."
- Emergency contact numbers.

8.9 Key Takeaways for Site Managers

- Non-negotiable: every site must have continuous, sealed barriers of adequate height.
- Gates are weak points: treat them as critical dust control features.
- Community visibility matters: barriers should look maintained, not neglected.
- Records protect you: photographs and logbooks are essential during inspections.

Chapter 9

Wet Suppression & Misting

9.1 Principle

Dust is best controlled at its source. Wet suppression uses water droplets to capture and settle airborne particles before they disperse. The most effective droplets are in the 10–100 μm range: small enough to remain airborne briefly and collide with dust, but large enough to fall and settle particles. Proper misting reduces visible plumes, lowers PM_{10} and $PM_{2.5}$ levels, and reassures nearby communities.

9.2 Methods of Application

Fixed Systems

- Pipe networks with misting nozzles installed along site perimeters and at dust-prone work zones.
- Nozzles positioned 2–3 m above ground, spaced at 3–4 m intervals for continuous coverage.
- Programmable timers to run misting cycles every 15–30 minutes.

Mobile Systems

- Anti-smog guns mounted on trucks or cranes to direct mist at demolition/cutting points.
- Portable, hand-held sprayers for small-scale works and short-term hotspots.

Road Sprinkling

- Water bowsers fitted with sprinkler bars to dampen haul roads and unpaved surfaces.
- Sprinkling to be done at least 2–3 times/day in dry months.

9.3 Droplet Size and Efficiency

- <10 μm: drifts with wind, ineffective for dust capture.
- 10–100 μm: optimal for binding suspended dust particles.
- >200 μm: falls too quickly, causes runoff with limited capture.

9.4 Scheduling

- **Continuous**: during cutting, grinding, drilling, or demolition.
- **Intermittent**: every 2–3 hours during excavation or stockpile management.
- **High frequency**: on dry and windy days, or during peak construction hours (08:00–11:00, 15:30–19:30).

9.5 Precautions

- Avoid over-wetting — stagnant water causes slip hazards and mosquito breeding.
- Ensure runoff drains into silt traps, not public drains.
- Place non-slip mats in areas where misting overlaps with pedestrian walkways.
- Inspect nozzles weekly for clogging and replace defective ones.

9.6 Monitoring and Record-Keeping

- Record daily misting run-time, water usage, and nozzle condition in the "Misting Logbook."
- Supervisors to sign off on misting cycles after visual confirmation of plume control (opacity <20%).
- Maintain water quality — avoid saline water that corrodes nozzles.

9.7 Advanced Technologies

- High-pressure atomisers producing ultra-fine mist for large areas.
- Automated sensor-linked misting systems that activate when $PM_{2.5}/PM_{10}$ exceeds thresholds.
- Combination systems that integrate misting with odour control in waste-handling zones.

9.8 Key Takeaways for Site Managers

- Always mist at the source of dust — perimeter-only misting is insufficient.
- Droplet size matters: aim for 10–100 μm to balance capture and settling.
- Keep clear records: logbooks and photos are essential for inspections.
- Treat misting as continuous maintenance, not a one-time installation.

Chapter 10

Wheel-Wash, Haul Roads & Logistics

10.1 Purpose

Vehicle movement is one of the largest contributors to dust spread beyond site boundaries. Soil and construction debris clinging to tyres and undercarriages are tracked onto public roads, where they are pulverised into fine PM_{10} and $PM_{2.5}$ dust by traffic. Proper wheel-wash systems, well-maintained haul roads, and controlled logistics are essential to breaking this chain.

10.2 Wheel-Wash Systems

Design Specifications

- Install at **all exits** where vehicles leave the site.
- Ramps with high-pressure spray nozzles positioned at wheel level and undercarriage.
- Minimum ramp length: 10 m to ensure full axle coverage.
- Drainage directed into **sediment traps** and settling pits.
- Capacity designed for peak traffic: at least 30–40 trucks/hour for medium sites.

Operation

- Mandatory wash for every truck and equipment vehicle exiting the site.
- Guards must verify wash completion before the gate is opened.
- Wheel-wash water recycled after silt settling and filtration.

Maintenance

- Daily cleaning of sediment pits to prevent overflow.
- Weekly inspection of pumps, filters, and nozzles.

- Replace clogged nozzles within 24 hours.

10.3 Haul Roads

Design

- All internal roads to be paved (concrete/asphalt) or stabilised with gravel.
- Width: minimum 6 m for two-way movement.
- Drainage ditches alongside to prevent pooling of water and mud.

Operational Controls

- Vehicle speed limited to 10–15 km/h, enforced with signage and CCTV.
- Sprinkling of water 2–3 times/day during dry months.
- Road cleaning with mechanical sweepers where available.

10.4 Logistics Management

Truck Operations

- All trucks must be covered with tarpaulins before leaving the site.
- Overloading prohibited — spillage during transport must be strictly penalised.
- Dedicated entry and exit gates to separate construction traffic from public flows.

Traffic Flow

- Internal circulation plans must be prepared and approved as part of the Dust Mitigation Plan.
- No vehicle queuing on public roads outside the site.
- Delivery schedules staggered to avoid congestion and idling.

10.5 Records and Compliance

- "Truck Exit Logbook" with date-stamped photos of tarpaulin-covered loads.
- Wheel-wash operation sheets signed daily by the site supervisor.
- Monthly maintenance reports of haul road surfacing and sprinkling.

10.6 Key Takeaways for Site Managers

- Every truck must be washed and covered before leaving.
- Paved and stabilised haul roads reduce dust generation by more than 80%.
- Logistics control is not just internal — preventing track-out protects community roads.
- Proper records are the only defence in case of regulatory inspections.

Chapter 11

Stockpiles & Material Handling

11.1 Purpose

Improper storage and handling of bulk materials such as sand, soil, cement, and fly ash can generate continuous dust emissions. Stockpiles exposed to wind and material drops during transfer are major sources of PM_{10} and $PM_{2.5}$. Effective management prevents pollution, reduces material loss, and ensures compliance.

11.2 Stockpiles

- Height limited to 2 m unless fully enclosed.
- Located away from boundaries, ideally downwind of sensitive receptors.
- Covered at all times with UV-resistant tarpaulin or geotextile fabric.
- Surrounded by wind-break fencing or vegetation belts.
- Surface kept moist using sprinklers or misting lines.

11.3 Cement and Fly Ash

- Stored only in sealed silos with dust-proof loading/unloading.
- Transfers via enclosed pneumatic or screw conveyor systems.
- Bagged cement to be stored indoors with sealed doors and minimum handling.
- Prohibit outdoor mixing or open transfer of cement/fly ash.

11.4 Material Transfer Points

- Enclosed chutes or covered conveyors used for loading and unloading.
- Ban free-fall dumping; use telescopic chutes to minimise drop height.

- Apply misting directly at conveyor discharge and hopper points.

11.5 Records

- Daily "Stockpile Cover Checklist" signed by supervisor.
- Weekly photographic documentation of tarpaulin covers and silos.
- Incident log for any uncovered or blown material.

11.6 Key Takeaways

- Cover every stockpile — no exceptions.
- Cement/fly ash must never be handled in the open.
- Record and photograph compliance daily.

Chapter 12

Demolition, Cutting & Grinding SOPs

12.1 Purpose

Demolition and mechanical cutting/grinding produce the highest levels of respirable crystalline silica (RCS), $PM_{2.5}$, and ultrafine dust. Strict standard operating procedures (SOPs) are required to protect both workers and neighbouring communities.

12.2 Demolition

- Pre-wet structures for at least 24 hours before demolition.
- Sequential floor-by-floor removal; avoid sudden collapses.
- Mist cannons positioned at impact points throughout operation.
- Prohibit explosive or uncontrolled knockdowns in populated areas.

12.3 Cutting and Grinding

- Dry cutting and grinding are strictly banned.
- Wet saws with continuous water feed mandatory.
- Local Exhaust Ventilation (LEV) attached to tools and connected to HEPA vacuums.
- Dust shields or enclosures used around high-dust machinery.

12.4 Drilling

- All drills fitted with vacuum dust collection systems.
- Operators provided with eye protection and N95/P100 respirators.

12.5 Worker Protection

- Respiratory PPE mandatory for all personnel in demolition/cutting areas.
- P100 recommended where silica-containing materials are involved.
- Operators to undergo regular fit-testing and training.

12.6 Monitoring

- Supervisor to maintain “Demolition Dust Log” with timings of misting, water usage, and LEV checks.
- Visual plume opacity kept under 20% during operation.

Chapter 13

Worker Protection & Health Surveillance

13.1 Purpose

Construction workers are the most exposed to dust and nanoparticles. Protecting their health is both a moral duty and a regulatory requirement.

13.2 Personal Protective Equipment (PPE)

- N95 respirators mandatory for general dust tasks.
- P100 or equivalent required for silica-heavy operations.
- Workers trained in correct donning, fit-checks, and disposal.
- Fit testing conducted annually.
- Gloves, goggles, and helmets provided where secondary risks exist.

13.3 Health Surveillance

- Pre-employment medical checks including spirometry.
- Annual lung function tests and chest X-rays for exposed workers.
- Maintain health records for 30 years, in line with international standards.

13.4 Training and Awareness

- Daily toolbox talks highlighting dust hazards and protective measures.
- Posters in Hindi, Marathi, and English displayed at work areas.
- Monthly refresher sessions with practical demonstrations.

13.5 Rest and Recovery Zones

- Indoor shelters with HEPA purifiers provided for breaks.
- Strictly no smoking to prevent compounding lung exposure.
- Drinking water stations placed in shaded, low-dust areas.

13.6 Key Takeaways

- PPE use is non-negotiable; enforcement is as important as supply.
- Health surveillance ensures early detection of lung impairment.
- Training in local languages is essential for real compliance.

Chapter 14

Scheduling, Weather & Work Planning

14.1 Purpose

Dust emissions are not constant; they depend heavily on timing and weather. Smart scheduling reduces community impacts without major cost.

14.2 Task Scheduling

- Demolition and cutting restricted to 08:00–20:00.
- Avoid dust-intensive work during school opening/closing times.
- Never run multiple high-dust tasks simultaneously.

14.3 Weather Adjustments

- Suspend work when wind speed exceeds 20 km/h.
- Increase misting during dry months (March–May, Oct–Dec).
- Reduce dust work during early morning winter inversions.
- Resume tasks only when visibility and wind conditions are stable.

14.4 Work Planning

- Prepare a daily "Dust Schedule" signed by EHS supervisor.
- Align truck movement with misting cycles.
- Sequence excavation, loading, and demolition to avoid peak overlaps.

14.5 Key Takeaways

- Timing can halve dust impact without extra cost.
- Weather is a critical control — always check forecasts.
- Document schedules in the “Work Planning Register.”

Chapter 15

Community Communication & Transparency

15.1 Purpose

Community trust is essential to maintaining a smooth project. Transparent communication on dust control prevents conflicts and builds goodwill.

15.2 Community Interface

- Notice boards at site gates with developer and EHS contact.
- LED display showing real-time PM_{10}/$PM_{2.5}$ readings.
- Hotline number for community complaints, staffed 24/7.

15.3 Reporting

- Weekly "Dust Bulletin" shared with nearby societies and RWAs.
- Monthly community meetings to discuss concerns.
- Third-party audit summaries displayed publicly.

15.4 Trust-Building Measures

- Invite RWA representatives for monthly site walkthroughs.
- Share corrective actions taken after complaints.
- Provide real-time air quality data access via web or app.

15.5 Key Takeaways

- Visibility and honesty are as important as technical controls.
- Sharing data reduces suspicion and strengthens compliance culture.

Chapter 16

Compliance, Record-Keeping & Audits

16.1 Purpose

Regulatory compliance relies on robust documentation. Without records, even compliant sites risk penalties. Good record-keeping also helps identify trends and improve controls.

16.2 Documentation

- Daily water logs (misting, wheel-wash, sprinkling).
- PPE distribution registers signed by workers.
- Truck cover and stockpile cover checklists.
- Incident logs for exceedances and corrective action.

16.3 Audits

- Weekly internal EHS audits with corrective action tracking.
- Monthly third-party audits for impartiality.
- Quarterly developer-led reviews to benchmark performance.

16.4 Evidence

- Date-stamped photos of barriers, misting, and stockpiles.
- Calibration certificates for PM monitors.
- Signed audit checklists retained for 5 years minimum.

16.5 Key Takeaways

- If it isn't recorded, it didn't happen.
- Keep logs simple but consistent.
- Evidence is your defence in inspections.

Chapter 17

Performance KPIs & Continuous Improvement

17.1 Purpose

Key Performance Indicators (KPIs) allow sites to measure dust control objectively. Continuous improvement ensures practices evolve with technology and community expectations.

17.2 KPIs

- % of days $PM_{2.5}$ within compliance levels.
- Number of exceedance events and average response time.
- % of workforce fit-tested for respirators.
- Number of community complaints and resolution rate.
- Average downtime due to dust-related stoppages.

17.3 Continuous Improvement

- Quarterly innovation trials (e.g., new misting guns, green additives).
- Annual review against international benchmarks (EU, OSHA).
- Incorporate community feedback into DMP updates.
- Share lessons learned across company projects to standardise best practice.

17.4 Key Takeaways

- KPIs make dust control measurable.
- Improvement is a cycle, not a one-off.

- Innovation must be tested and documented.

Appendix A

Checklists & Forms

A.1 Daily Site Dust Control Checklist

- Perimeter barriers intact, no gaps or holes.
- Misting/fogging operational at active work zones.
- Wheel-wash functional, sediment pit cleaned.
- All trucks covered with tarpaulin before exit.
- Stockpiles covered and/or moistened.
- PPE (respirators, goggles) distributed and worn.
- Rest shelters clean, purifiers operational.
- Daily logbook entries completed and signed by supervisor.

A.2 Weekly Audit Form

Parameter	**Compliant (Yes/No)**	**Comments/Actions**
Barrier height and condition		
Stockpile coverage		
Wheel-wash O&M		
Truck tarpaulin check		
PPE compliance		
Community complaints logged		

A.3 Incident Reporting Form

- Date and Time of Incident:
- Activity (demolition, excavation, etc.):

- Observed Dust Levels (visual or monitor data):
- Immediate Actions Taken:
- Community Complaints Received:
- Supervisor Signature:

Appendix B

Standard Operating Procedures

B.1 Demolition

1. Pre-wet structure 24 hours before activity.
2. Deploy mist cannons at impact zones.
3. Restrict work to 08:00–20:00.
4. Workers equipped with P100 respirators.
5. Supervisor maintains “Demolition Dust Log.”

B.2 Cutting and Grinding

1. Dry cutting banned.
2. Use wet saws with continuous water feed.
3. Attach LEV to all cutting tools.
4. Operators trained and fit-tested for respirators.
5. PPE log updated daily.

B.3 Stockpile Management

1. Limit stockpile height to 2 m.
2. Cover all piles with tarpaulin.
3. Mist stockpiles twice daily during dry season.
4. Record compliance in “Stockpile Cover Checklist.”

Appendix C

Method Statements

C.1 Wheel-Wash Operation

1. All trucks routed through wheel-wash before exit.
2. Guards verify tarpaulin cover before gate opens.
3. Sediment pits cleaned daily.
4. Operation times logged by supervisor.

C.2 Misting Systems

1. Fixed nozzles operated every 30 minutes during peak dust activity.
2. Mobile cannons deployed during demolition and excavation.
3. Anti-smog guns tested before daily shift.
4. Supervisor records water usage and downtime.

C.3 PPE Distribution

1. Respirators issued at morning muster.
2. Fit-checks performed daily.
3. Replacement stock monitored weekly.
4. Training provided monthly in Hindi/Marathi.

Appendix D

Templates (EMP, DMP, Notices)

D.1 Environmental Management Plan (EMP) Template

- Project details: name, location, developer.
- Identified dust sources (excavation, demolition, stockpiles).
- Mitigation measures (barriers, misting, wheel-wash).
- Monitoring plan (PM_{10}/$PM_{2.5}$ locations, frequency).
- Roles and responsibilities (developer, PMC, contractor).
- Reporting and escalation protocols.

D.2 Dust Mitigation Plan (DMP) Template

- Scope of work covered.
- Daily dust control methods with schedule.
- PPE programme details.
- Emergency response for dust exceedances.
- Community communication plan.

D.3 Community Notice Template

- Project name and duration.
- Key dust control measures in place.
- Contact details of EHS officer.
- Emergency hotline for complaints.
- Assurance of compliance with BMC/MPCB rules.

Appendix E

Glossary of Terms

ACH Air Changes per Hour — measure of how often air is replaced in a room.

CADR Clean Air Delivery Rate — measure of purifier effectiveness in m^3/h.

C&D Waste Construction and Demolition Waste.

DMP Dust Mitigation Plan.

EHS Environment, Health, and Safety.

HEPA High-Efficiency Particulate Air filter — capable of removing 99.97% of particles $\geq$0.3 µm.

LEV Local Exhaust Ventilation — system to capture dust at source.

MERV Minimum Efficiency Reporting Value — rating for air filters.

PM_{10} Particulate matter with diameter $\leq$10 µm.

$PM_{2.5}$ Particulate matter with diameter $\leq$2.5 µm.

PPE Personal Protective Equipment.

RCS Respirable Crystalline Silica.

RWA Resident Welfare Association.

SOP Standard Operating Procedure.