Environmental Considerations in Concrete Recycling




Tara Cavalline, Ph.D., P.E.
Assistant Professor, UNC Charlotte

Environmental Considerations in Concrete Recycling Webinar

Learning Objectives

- To understand RCA production and use factors potentially impacting environment, specifically:
  - Water quality
  - Air quality
  - Noise and other local impacts
  - Waste generation
- To identify design/specification considerations that can reduce environmental impacts of RCA while in service
- To identify controls that can be utilized during RCA production and construction to reduce potential environmental impacts
- To understand legislative and regulatory considerations associated with RCA and means to remove barriers to RCA use

Webinar Overview

- Introduction
- Legislative and Regulatory Considerations
- Potential Environmental Impacts
- Design/Specification Considerations
- Environmental Controls During Construction
- Summary and Recommendations
- User Resources

Photo: Dwayne Stenlund, MnDOT

Environmental Considerations in Concrete Recycling

INTRODUCTION

Concrete Recycling

- Breaking, removing and crushing hardened concrete from an acceptable source.
- Old concrete pavements often are excellent sources of material for producing recycled concrete aggregate (RCA).
- This webinar focuses primarily on RCA from existing pavements (not mixed C&D waste).

Reasons for Recycling

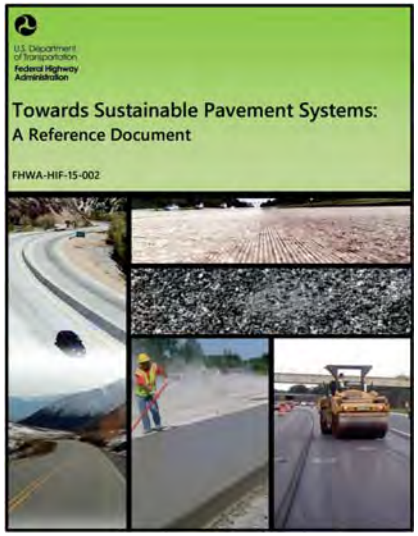
- Economic benefits
  - Cost savings
  - Benefits to project execution
  - Potential performance improvements
- Environmental benefits
  - Conservation of aggregates, energy
  - Reduction of landfill use
  - Reduction of greenhouse gases
  - Sequestration of carbon
- Societal benefits
  - Reduced land use
  - Reduced impact to landscape
  - Potential reduction in traffic/noise (particularly with on-site recycling)

Focus of this Webinar

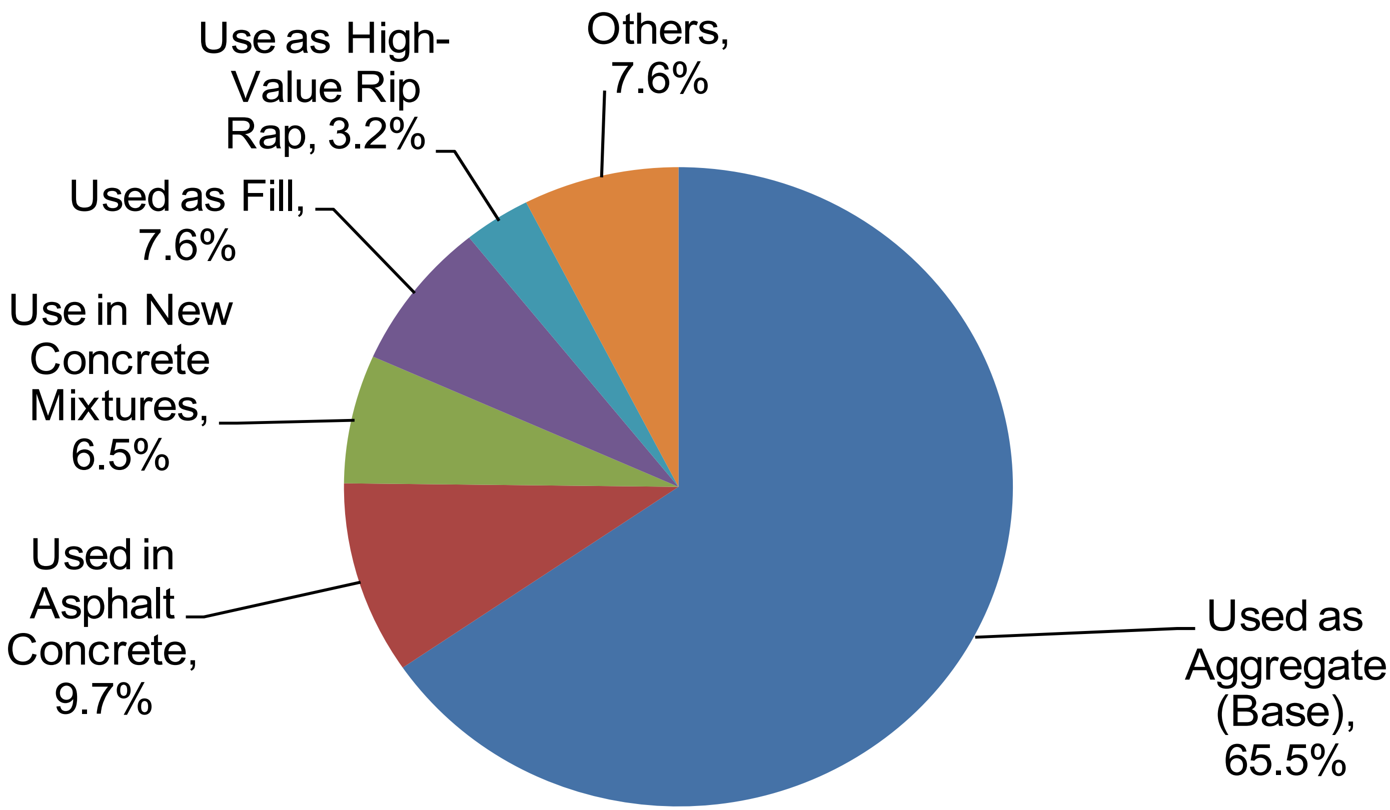
Recycling is inherently an environmentally beneficial practice,
but
must mitigate potential adverse impacts on
the environment and human health

There appears to be no negative environmental effects from using RCA that significantly offset the positive environmental effect of reduced use of virgin aggregate and landfills

(FHWA HIF-15-002, and Reiner 2008)



Current Uses of RCA Nationally



Source: Van Dam et al. 2015, from
C&D Debris Recycling Magazine, 1998

Environmental Considerations in Concrete Recycling

LEGISLATIVE AND REGULATORY CONSIDERATIONS

Federal Legislation – Water Quality

- Clean Water Act (CWA) and Federal Water Pollution Control Act and Amendments
  - NPDES regulations
    - Operators of Municipal Separate Storm Sewer Systems (MS4s) must:
      - Obtain an NPDES permit and
      - Develop a stormwater management plan
- National Environmental Policy Act (NEPA)
  - Enforceable obligations requiring federal agencies to identify environmental impacts of planned activities
  - Framework under which environmental impacts are evaluated
  - Starting point for application/enforcement of other environmental regulations (Austin 2010)

State Regulation – Water Quality

- Most state DOTs implement their own NPDES permit program
  - Wide variation in permitting approaches - NCHRP Report 565 (Austin 2010)
  - Minimum approaches include:
    - » Construction runoff control
    - » Post-construction controls
    - » Pollution prevention and good housekeeping
    - » Total Maximum Daily Load (TMDL) compliance
    - » Monitoring requirements

- Stormwater Pollution Prevention Plan (SWPPP), aka
  - Erosion and Sediment Control Plan
  - Construction Site Best Management Practices Plan, etc.

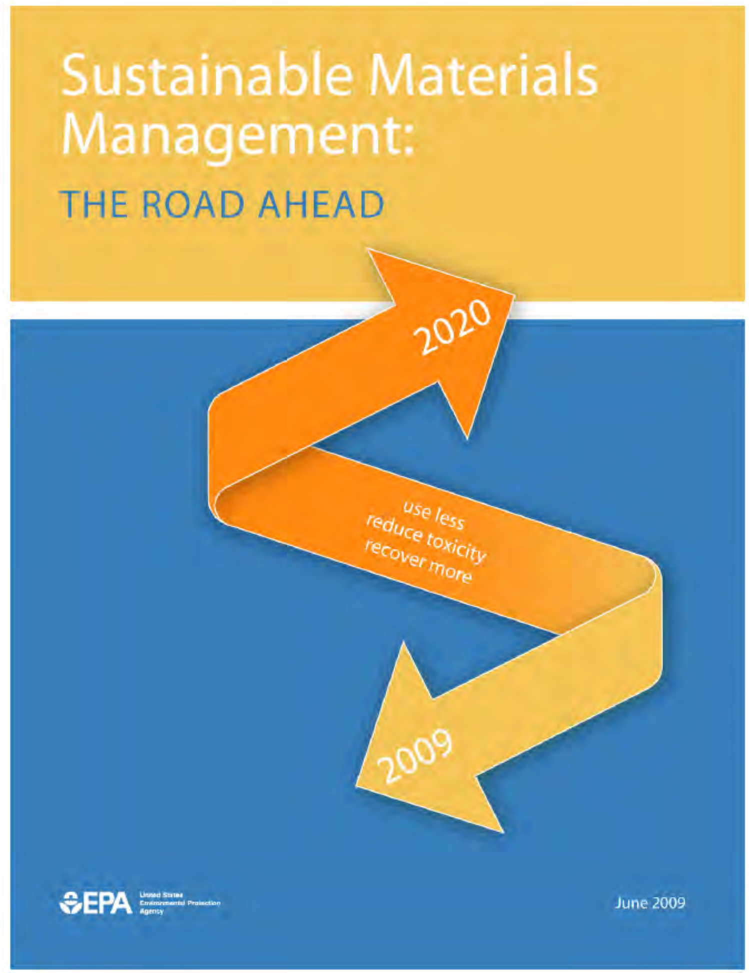
Best Management Practices (BMPs)
to address potential impacts of RCA during construction/use can be incorporated in SWPPP.

Federal Legislation – Waste

Resource Conservation and Recovery Act (RCRA)

  - EPA regulates disposal of Hazardous Solid Waste
  - States encouraged to develop solid waste management plans

- RCRA provisions relevant for some highway construction and maintenance activities
  - Classification of RCA and treatment under RCRA important
- Regulatory policies differ by state
- RCA is typically defined as an inert material



Environmental Considerations in Concrete Recycling

POTENTIAL ENVIRONMENTAL IMPACTS OF CONCRETE RECYCLING

Potential Environmental Impacts

- Water quality
  - Contaminants in runoff and drainage
  - Alkalinity, chemical contaminants, other
  - Transported sediments
- Air quality
  - Equipment emissions
  - Fugitive dust
- Noise, other local impacts
  - Additional processing, handling
  - Traffic
- Waste generation and disposition
  - Solids, wastewater, slurries, residuals

Photo: Dwayne Stenlund, MnDOT

Must be mindful of (and mitigate) adverse environmental impacts. Treat RCA as an engineered material.

Quality of Source Concrete

- Source concrete often contains contaminants
- Typically only a concern if RCA used in new concrete

MRD?

  - **Oil** typically not present in an amount to cause concern
  - **Chlorides** can promote corrosion of dowels, reinforcing bars
    - One study chloride levels: RCA 1.2 kg/m^3, virgin aggregate 0.6 kg/m^3 (Yjranson 1989, Strand 1985, Young 1980)
    - Typical limit for highly reinforced concrete is 2.4 kg/m^3
    - No reported corrosion issues in RCA field studies conducted to date
  - **Sulfates** could cause expansion and damage
    - Not reported as issue in RCA field studies conducted to date

These contaminants are not likely present in appreciable amounts
(NHI 1998)

RCA Leachate/Runoff Characteristics

Leachate from RCA in-situ, AND runoff from stockpiles:

- Alkaline (high pH)
  - Primarily from dissolution of exposed $Ca(OH)_2$, a byproduct of hydration of cement
- Can contain chemical contaminants
  - Salts, heavy metals, metalloids, and polycyclic aromatic hydrocarbons (PAHs) (Schwab et al. 2014)
  - Heavy metals (from fly ash as well as natural rock) (ACPA 2008)
  - Lead, asbestos, other chemicals
  - Typically an issue when recycling offsite or commercially sourced concrete
- Can cause formation of deposits in and around pavement drainage systems
  - Tufa (calcium carbonate precipitate) and insoluble residue

RCA Leachate/Runoff Impacts

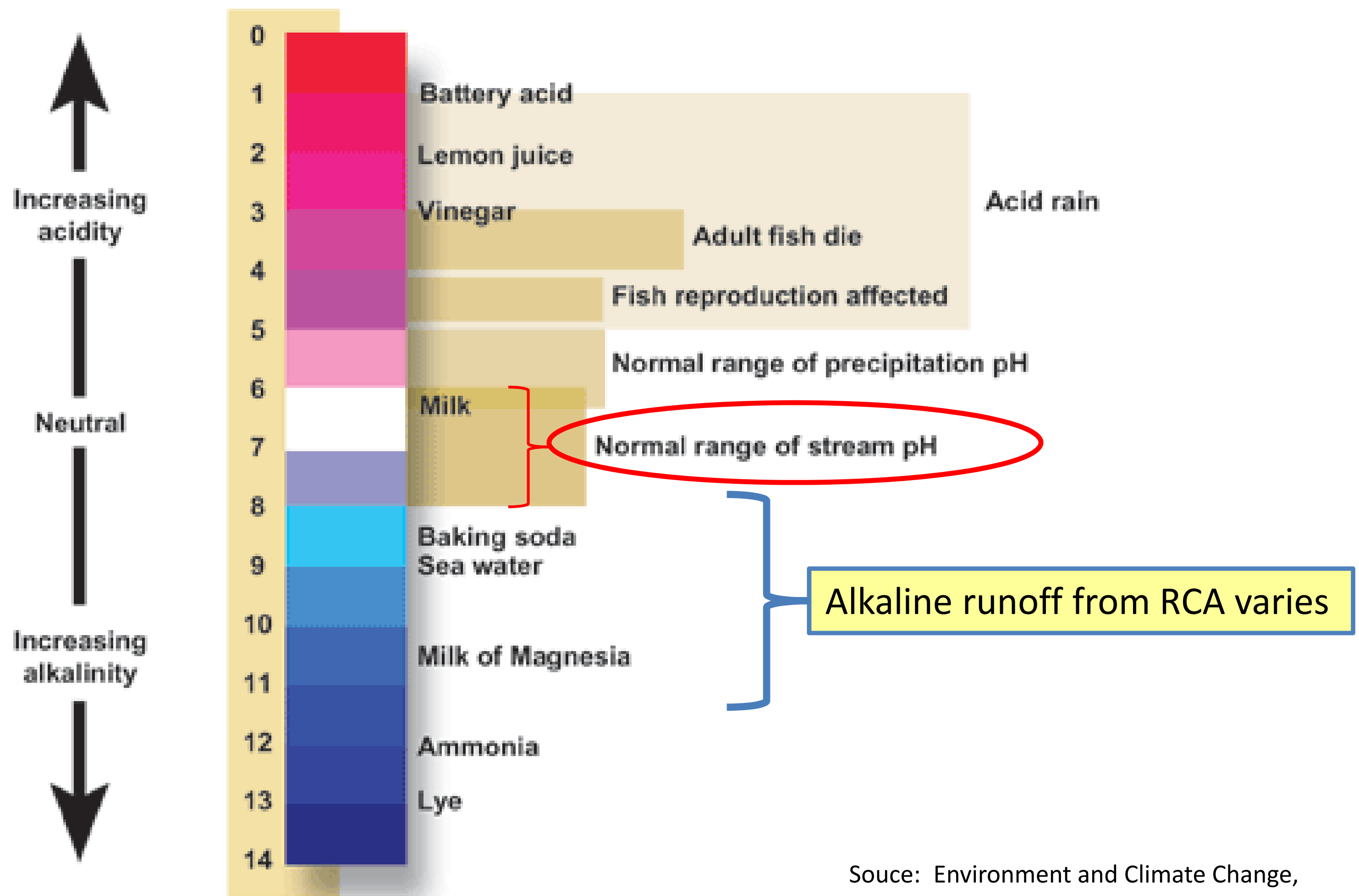
- Alkaline (high pH) runoff/leachate can impact:
  - Receiving natural waters
  - Vegetation
  - Zinc-coated and aluminum pipe (corrosion)

- Chemical contam
  - Toxic to humans
  - Harmful to ecos
  - Harmful to built environment (primarily chlorides)

- Deposit formations may cause serviceability problems

Photos: Dwayne Stenlund, MnDOT (left), PennDOT (right)

pH Scale



Souce: Environment and Climate Change, Canada, and www.usepa.gov

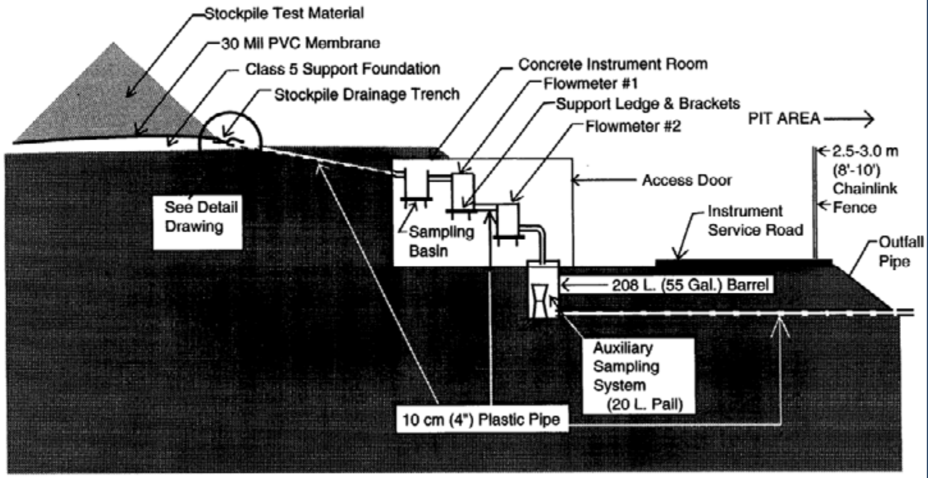
MnDOT Stockpile Runoff Project early 1990s

- Leachate from stockpiles analyzed (Sadecki et al. 1996)

Stockpile	Median pH
Fine RCA	9.3
Coarse RCA	9.8
RAP	8.5

Recommendations:
- Berms, straw bales, grass/filter channels
- Site selection away from surface waters
- additional study to determine safe distance from receiving water bodies

- pH and chromium contents may have exceeded Minnesota standards for surface waters
- Long-term concern - suspended/dissolved solids and pH



From Sadecki et al. 1996

Recent Water Quality Research
Recycled Materials Resource Center

- Long term tests with RCA sourced from CA, CO, MN, MI, TX, NJ, OH, WI
  - "fresh" RCA (recently crushed)
  - weathered RCA (from stockpiles)

Photo: Chen et al., 2012

- LAB - Column leaching tests
- Consistently high pH (10.8 to 12.5) for all RCA samples throughout the duration of the test (Chen et al. 2013)

- FIELD Sites at UW-M Campus
  - Fresh RCA
    - high pH leachate initially and for duration of test (12.6)
  - Stockpiled RCA (5-10 years)
    - low initial pH (7.3) leachate, increased to 12.1 over time

Stockpiled RCA subjected to changes/degradation in cement phases – consumption of $Ca(OH)_2$, carbonation, secondary cementing

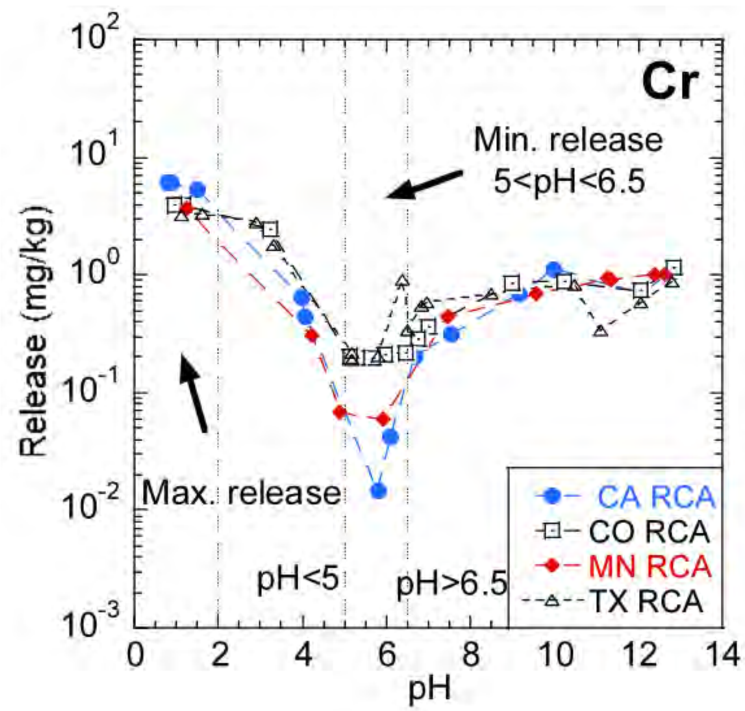
RCA Leachate/Runoff Characteristics

- Changes in RCA over time changes pH, alkalinity of leachate:
  - Consumption of available $Ca(OH)_2$
  - Dissolution of calcium carbonate (carbonation) of RCA
  - Additional hydration of cementitious materials

(Edil et al. 2012)

- Leaching characteristics of many chemical contaminants from RCA is highly dependent on pH
  - Particularly for heavy metals

(Engelsen et al. 2010, Edil et al. 2012)



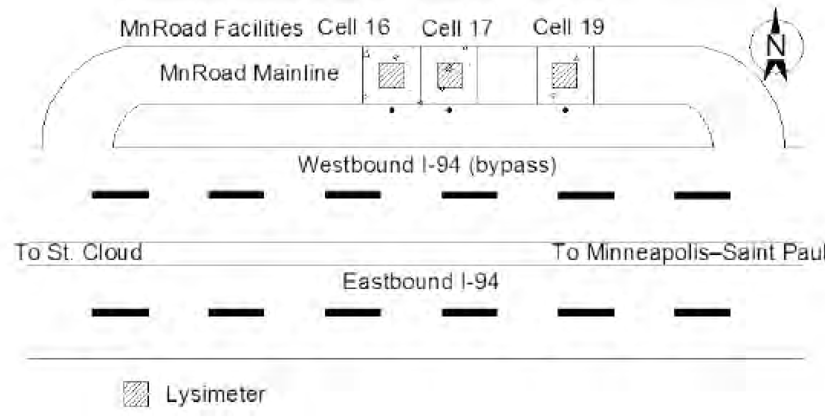
pH dependent release of Chromium from RCA

from Chen et al., Univ. of Wisconsin-Madison, 2012

Recent Field Studies

Recycled Materials Resource Center

THE UNIVERSITY of WISCONSIN MADISON



MnROAD Test Facility Field Study Site
from Chen et al., 2012

Leachate tests from MnROAD field site conflict with lab results

- Consistently neutral pH (6.6 to 8.0) was measured in field
- Carbonation of RCA due to percolating water, preferential flow in roadbed due to weathering

- Concentrations of a few metals all higher than maximum contaminant limits for EPA drinking water standards at some point in both field and lab tests
- Fine particles tend to leach more of some metals than sand/gravel sized particles

Other findings…

Norway field studies monitored for over 4 years

(Engelson et al. 2010/2012, Mulugeta et al. 2011)

- Several test sections monitored (ACC/PCC over RCA, uncovered RCA)
- pH of ACC covered RCA decreased from 12.6 to below 10 after 2.5 years of exposure.
- pH of uncovered RCA decreased same amount in approximately 1 year

- Contaminant release rate depended on pH and temperature
- Field leachate concentrations of most elements initially ↑, then ↓
- Contaminant concentrations did not exceed Norwegian acceptance criteria

Other research studies:

(Galvin et al. 2014)

- Compaction of RCA results in higher release rates for some pollutants

The characteristics of leachate from unbound RCA will vary over time, based upon composition, gradation, exposure to moisture, and other factors

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All RCA is capable of producing precipitate (tufa) and insoluble residue ("crusher dust")

Tufa - calcium-based mineral deposits

- Can affect permeability of geotextiles, gravel drain fields, drain field piping, or open soil-lined stormwater retention or detention facilities

Deposit formation affected by: (Bruinsma and Snyder 1995)

- – Surface area of RCA
- – Paste content – freshly exposed paste
- – Minerals present
- – Temperature
- – Presence of CO_2

- Usually not a problem below drains or in undrained layers
- In drained layers, can get infill of drain pipes and/or clogging of rodent screens.

Photos: Iowa DOT and PennDOT

Sediments & Solid Precipitate

Bruinsma and Snyder (1995)

- All untreated granular bases (even without RCA) have potential for deposits of crusher dust
- Precipitate formation related to freshly exposed paste
- ↓ potential by ↓ finer material
  - use open gradation or pretreatment methods

Ceylan et al. (2014) - field study of Iowa pavements

- ↓ tufa formation from RCA base is observed with
  - Use of plastic (PVC) outlet pipe without the use of rodent guards
  - Use of blended RCA and virgin materials
- "tufa from RCA materials do not need to be mitigated or removed through any alternative solutions such as RCA material quality control, outlet design, and maintenance, etc."

Sediments and solid precipitate formation from RCA typically not extensive enough to warrant exclusion from most uses

Leaching concerns with RCA Concrete?

Laboratory studies:

- RCA concrete tends to leach higher levels of metals than conventional concrete
- Leachability of metals depends on type of metal, pH, carbonation, and mobility characteristics

(Galvin et al. 2014)

Photo: Mark Snyder, MnDOT RCA Concrete

Use of RCA in concrete mixtures mitigates water quality issues associated with leaching.

Water quality issues associated with use of RCA in bound applications have not been reported.

Air Quality
Impacts of RCA Operations

- Typically two concerns:
  - Dust
  - Emissions
- Sourced from:
  - production equipment
  - hauling equipment
- Nuisance
- Health hazard

New OSHA Crystalline Silica Rule

Photos: Dwayne Stenlund, MnDOT

Noise and other Local Impacts

Recycled aggregates operations can be seen as "unneighbourly"

(UK Dept of Environment, Transport, and Regions 2000)

- Visual impact of recycling operations/plants
- Traffic – congestion, delay, safety
- Noise and vibration:
  - Engines powering crushing and screening equipment
  - Material in chutes/hoppers
  - Vehicles
- Dust, other emissions
- Nature of operation is such that noise/vibration cannot be entirely reduced (O'Mahony 1990)

Lower photo: Tom Cackler

Waste Generation – Concrete Residuals

Photos: MnDOT (upper), Tom Cackler (lower)

- Crusher fines
- Slurries, wastewater

- Sources:
  - Unutilized portion of RCA (coarse or fine)
  - Washwater from equipment, vehicles
  - Residual source concrete not utilized
- Amount produced varies by source, technique utilized

Environmental Considerations in Concrete Recycling

DESIGN/SPECIFICATION CONSIDERATIONS

Specification Considerations

Known vs. unknown sources to reduce chemical contaminants
One means of addressing this is prequalification of source material

- Example: WSDOT
- Standard specifications 0-03.21 – Recycled Materials
  - "Recycled materials obtained from the Contracting Agency's roadways **will not** require toxicity testing or certification for toxicity characteristics."
  - "Recycled materials that are imported to the jobsite **will require** testing and certification for toxicity characteristics."
    - Sampling protocol outlined for:
      - lead
      - Toxicity Characteristic Leaching Procedure (TCLP)
      - certification that the recycled materials are not WA State Dangerous Wastes
      - compliance with other standard specs

AASHTO M 319-02

Standard Specification for

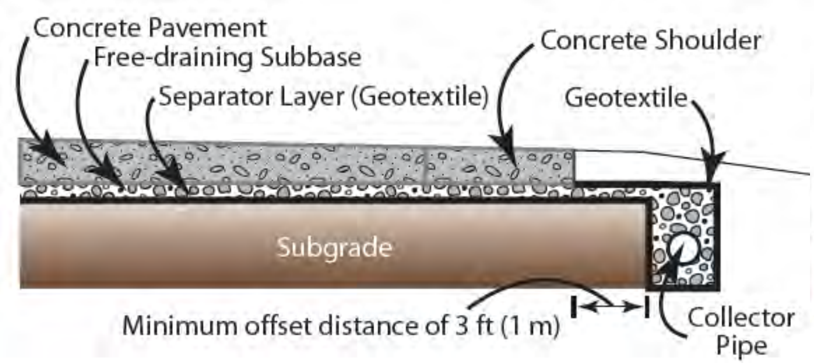
Reclaimed Concrete Aggregate for Unbound Soil-Aggregate Base Course

AASHTO Designation: M 319-02 (2010)

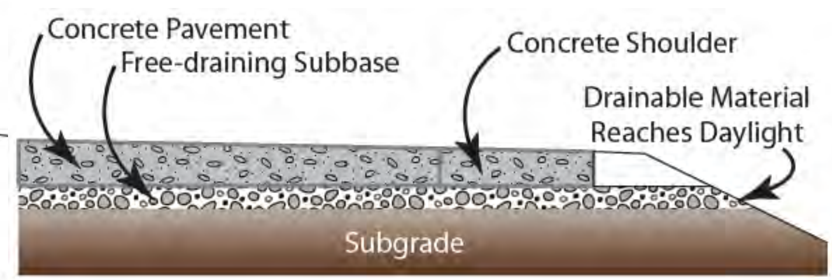
- Provides limits on contaminants in the RCA
- Language for stockpile management
- Guidance for:
  - Assessment of RCA
  - Lot/sublot descriptions and sizes to help guide testing/acceptance
  - Approval of RCA not meeting contaminant materials limits
- Validation of geotextile or fine-grained drainage layer by:
  - Field experience
  - Comparative permeability testing

Recommendations – Preventing Drainage Structure Clogging

- Minimize use of RCA fines
- Crush to eliminate reclaimed mortar
- Blend RCA and virgin materials
- Use largest practical RCA particle sizes.
- Consider washing RCA to reduce insoluble residue (crusher dust) deposits.
- Use high-permittivity fabric
- Wrap trench, not pipe
- Consider daylighted subbase



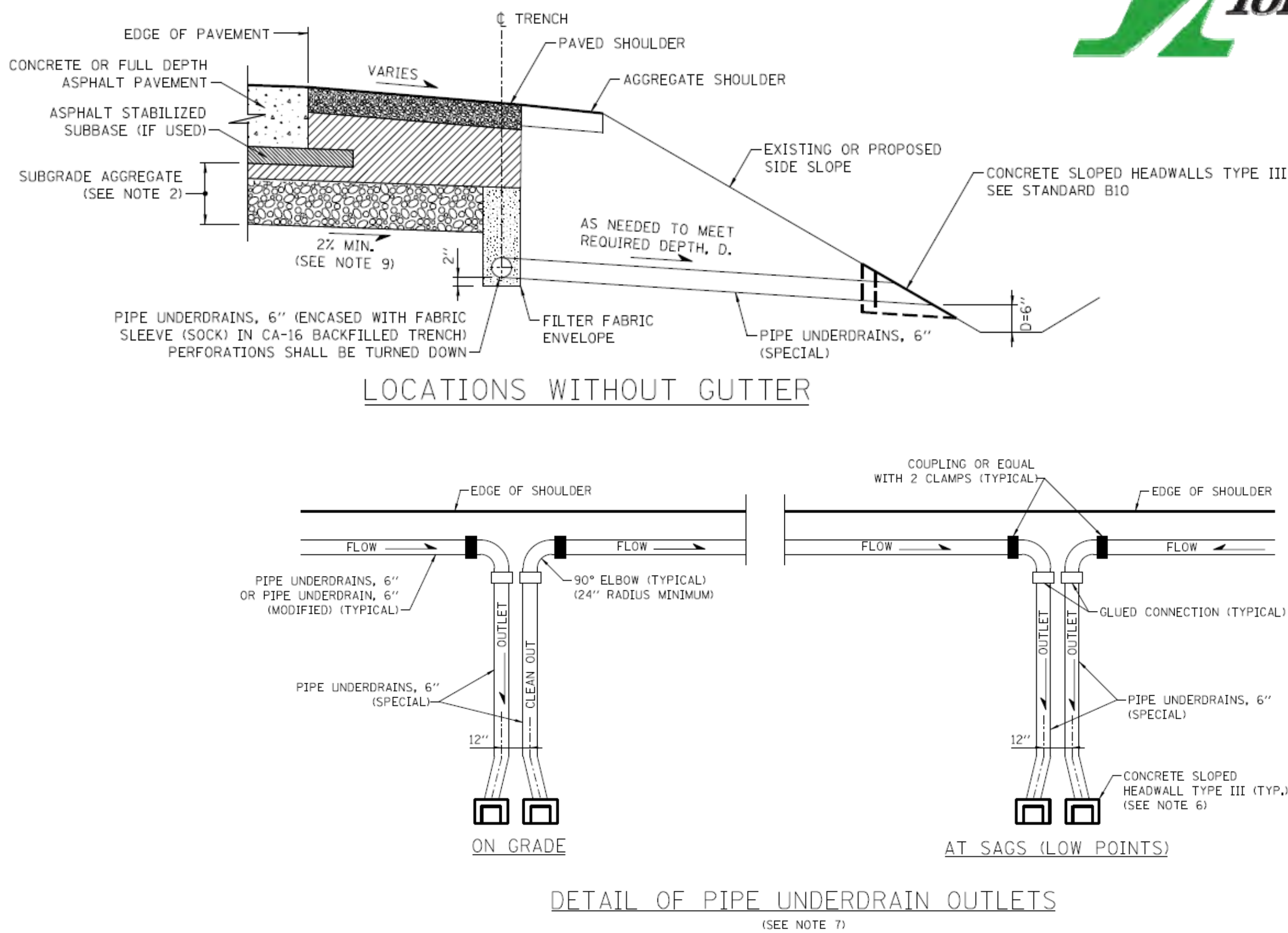
Typical edge drain piping (ACPA 2008)



Typical daylighted subbase (ACPA 2008)

Drain details for unbound base layers

- Used successfully with RCA by Illinois Tollway



Environmental Considerations in Concrete Recycling

ENVIRONMENTAL CONTROLS DURING CONSTRUCTION

Minimizing Jobsite Footprint

"Be wary of sensitive receptors" (DETR 2000)

Reduce impacts from
- noise
- traffic
- light
- dust
- water pollutants

Site selection: Onsite vs. offsite

Well-implemented onsite material crushing program. Water spray source was freeze depressed by addition of automobile window wash fluid
(from Dwayne Stendlund, MnDOT)

Reducing Jobsite Impacts (DETR 2000)

LOCATION

- On-site recycling (or close)
- Location away from sensitive areas
- Account for prevailing wind conditions
- Use buildings, natural topography, or vegetation as wind screen
- Provide noise attenuation barriers

SITE LAYOUT

- Minimize haul distances
- Encourage two-way transport to reduce trips
- Reduce vehicle movements

SITE CONTROLS

- Haul road surfacing, chemical stabilization of surfaces
- Application of water – misters, spray rigs/nozzles for prewetting

Photo: Dwayne Stenlund, MnDOT

Reducing Jobsite Impacts (DETR 2000)

reducing vehicle speeds from 30 mph to 20 mph reduces dust emissions by 22 percent (BCPH 2017)

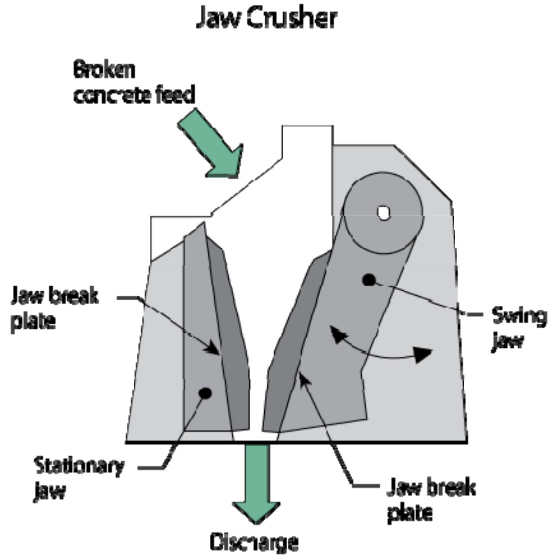
OPERATIONS

- Work during periods of low wind velocities
- Minimize drop height of material
- Use chutes/conveyors
- Reduce vehicle speeds
- Shrouds, tarps on haul trucks
- Vehicle wheel and chassis washes
- Stockpile controls
  – Limit height of stockpiles and disturbance
  – Cover or provide a three-sided wind barrier
- Maintain vehicles and plant equipment
  – Maximize fuel efficiency, utilize emissions checks
  – Avoid leaving plant equipment and/or vehicles operating unnecessarily

Photos: Dwayne Stenlund, MnDOT

Reducing Fines Production

- Selection of crusher type is important
- Jaw-type crushers should be utilized for primary crushing (NHI 2004)
- Impact crusher tends to produce many more fines (Yrjanson 1989, O'Mahony 1990)



(Photos: Tom Cackler)

Air Quality
OSHA Crystalline Silica Rule

Tech Center

- Protects workers from respirable crystalline silica (RCS)
- Construction Standard applies to concrete paving operations

Table 1: Specified Exposure Control Methods When Working with Materials Containing Crystalline Silica

Engineering and work practice control methods
and
Required respiratory protection and assigned protection factors (APF)

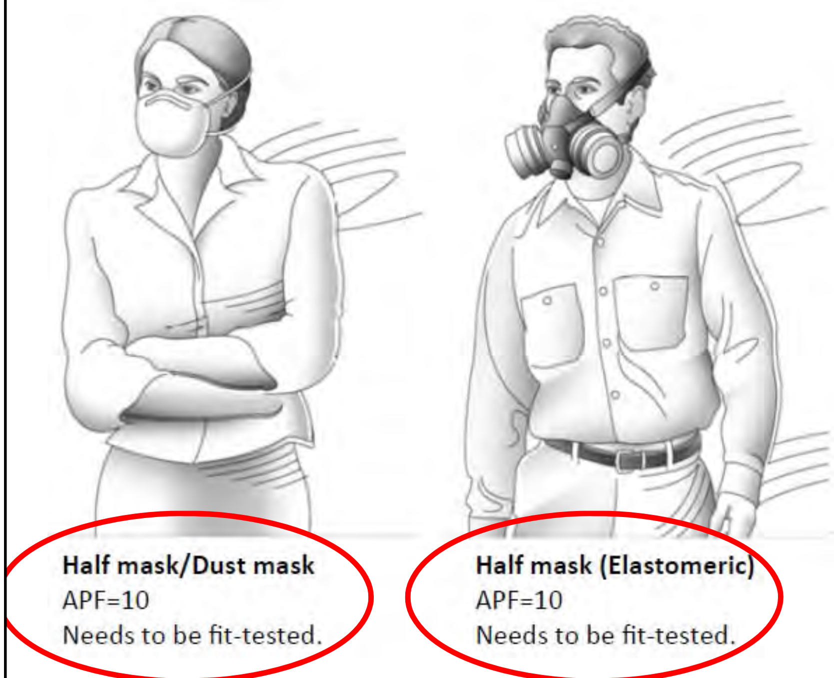
handheld tools than larger machines

Larger machines: Crushers, heavy equipment and utility vehicles

- Use spraying/misters, enclosed cab, maintain equipment
- No Required Respiratory Protection and Minimum APF

Jackhammers and handheld powered chipping tools:

- Water delivery systems, operate from enclosure, dust suppression measures
- When operated outside of enclosure/cab, need APF 10 respiratory protection (all durations indoors/enclosed, >4 hours outdoors)



From OSHA (2009)

Example concrete crushing dust suppression system (photo: Duit Construction).

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OSHA Crystalline Silica Rule

Written Exposure Control Plan must be established and implemented by all construction employers covered by OSHA

- Employers not complying with Table 1 must follow alternative exposure control methods
  - Assessing RCS by measuring employee exposure
  - Requires consultant to assess air quality during performance or sample/test personal breathing zone air samples
- Recommended to consult OSHA documents directly.
- ACPA Technical Bulletin available at www.wikipave.org

Technical Bulletin

Understanding OSHA's Crystalline Silica Rule

Stockpile Management – Best Practices

- For RCA, many states generally refer to handling/stockpiling practices for conventional aggregates
- Store material sourced from different types of concrete in separate stockpiles

"Clean" stockpile for RCA production

Stockpile of broken concrete with excessive fines

Photos: Iowa DOT - IM 210

Stockpile Management - Best Practices

- Select location to mitigate impact on surface waters
- Traditional physical controls
- *Redundant perimeter controls*
  – Berms, straw bales, filter channels
  – Silt fences
  – Trench encircling stockpile
  – Control drainage to maintained sediment trap
  – Nearby stormwater inlets off-line

Stockpiles for crushing set inside roadway depression with inlets offline
(source: Dwayne Stenlund, MnDOT)

Stockpile Management - Best Practices

Demolished material stockpiled beneath bridge prior to crushing. Silt fence and upland vegetative buffer used.

High-performance perimeter control using concrete blocks wrapped in geotextile fabric.

Could also use crushed concrete wrapped in geotextile.

Source: Dwayne Stenlund, MnDOT

RCA can actually be used in stormwater BMPs as filter material!

RCA used as filter for concrete slurry removal produced by other processes

- Salvaged RCA base reclaimed as berm for perimeter control of sawcutting slurry, along with sediment control “log.”
- Water exits clear, checked for pH, adjusted to 7.0 ± 1.0 using CO_2 bubblers

Source: Dwayne Stenlund, MnDOT

Stockpile Management – Best Practices

- Control height (WSDOT - 24 ft max)
- Minimize fines

- Moisture control – recementing of particles
  - Bigger issue in stockpiles of fine aggregate
    - surface area, contact area
  - Open graded materials may not become recemented within short term (1 year) (Snyder 1996)

- Covers – geotextile or plastic
- Mist area with water for dust control

Plastic cover and perimeter berm

Photos: Dwayne Stenlund, MnDOT

Water Quality – Perimeter Control

Source: Dwayne Stenlund, MnDOT

Perimeter control at waterway near demolition and concrete crushing operations

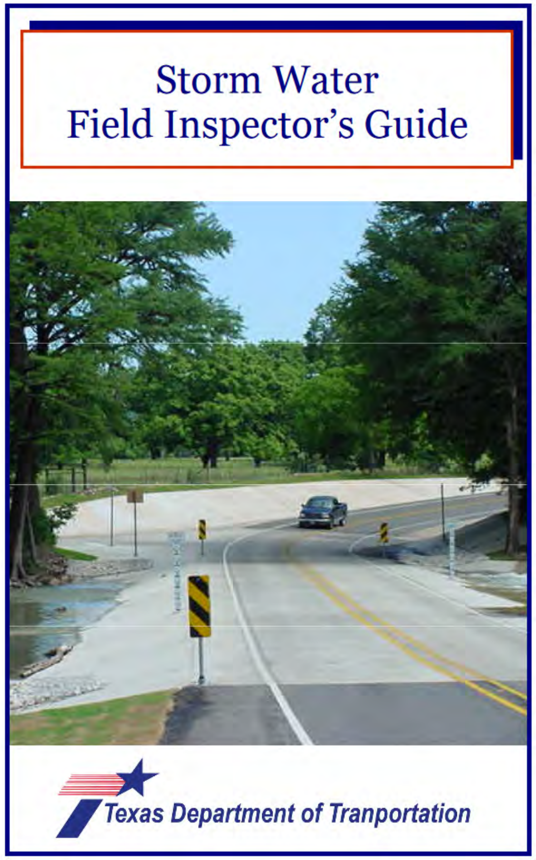
- geotextile wrapped Jersey barriers
- RCA filter berm on inside
- water for dust suppression

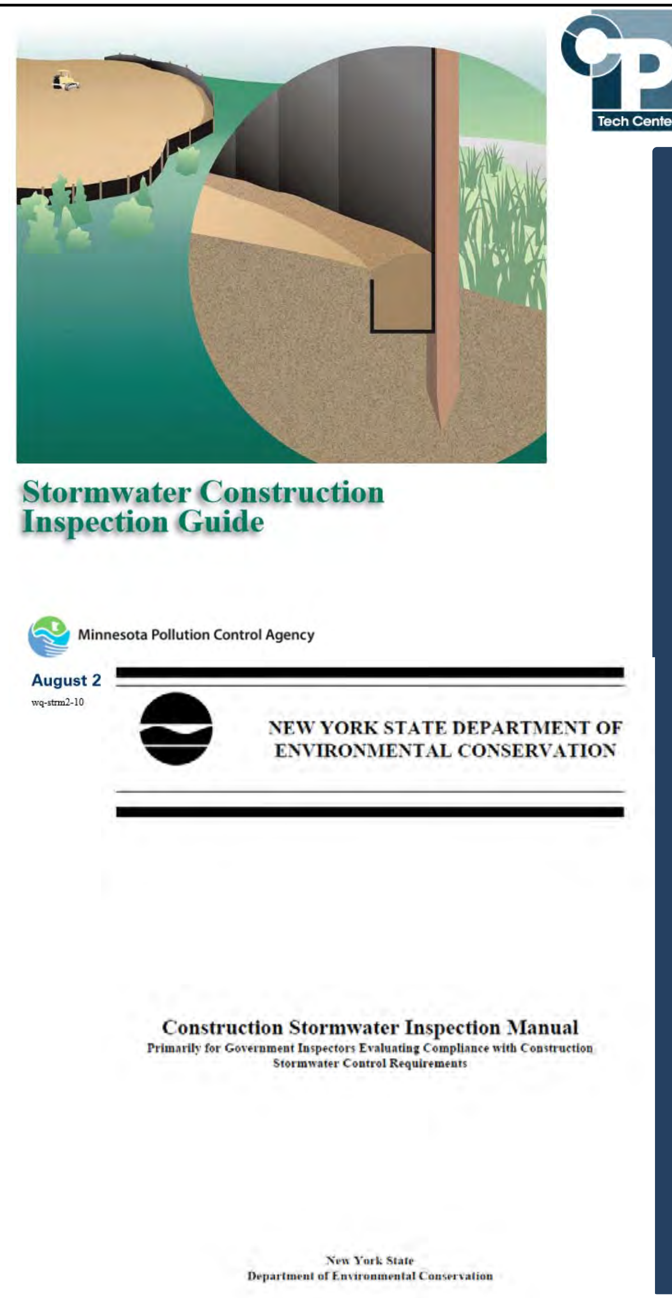
Water Quality Monitoring and Testing

- NPDES Permit
- SWPPP Plan

Compliance with applicable federal/state/local regulations:

- What to test for
- How to test for it
- Frequency of monitoring





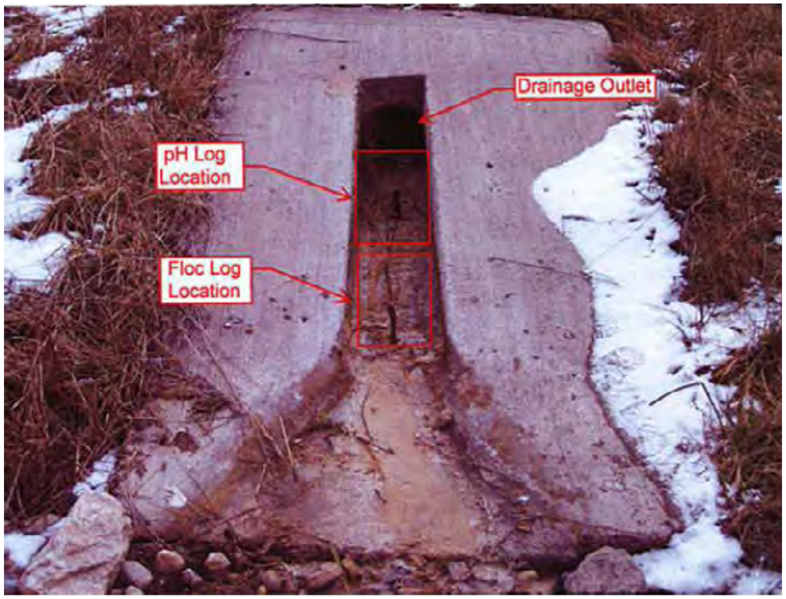
Case Study – Water Quality

I-94 project, RCA granular subbase

- Sediment-laden, high pH discharge from several underdrain outlets
  - One underdrain about 25 feet from receiving waterway
- Reported discharge to IEPA, cleaned out drain
- Discharge persisted

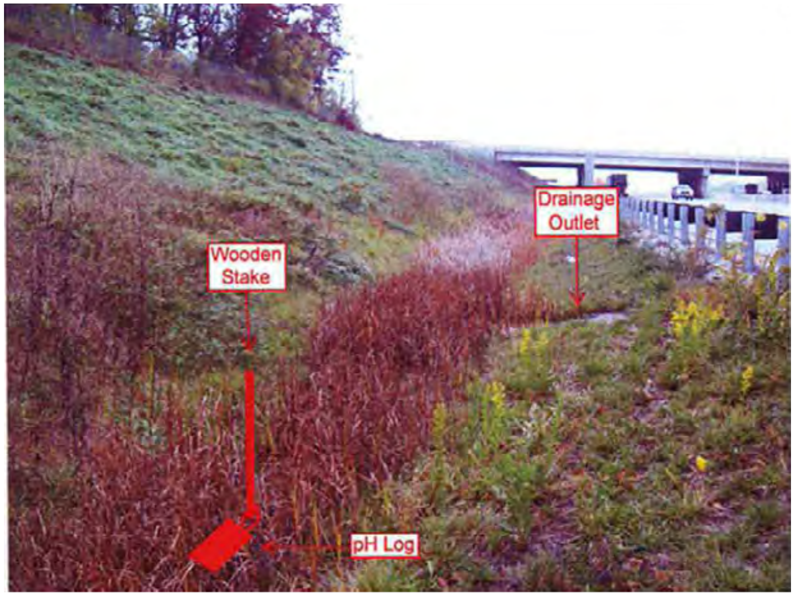
- Mitigation approaches:
  - Constructed small catch basin at pipe outlet
  - Floc logs – polyacrylamide products that flocculate/chelate suspended and dissolved solids
  - pH logs (or "shock logs") – used to reduce pH
  - Bioswales (biological treatment features)

Photos: Siltstop (upper), Hydrograss Technologies (lower)



↕ Outlet approx. 25ft from stream ↕

↕ Outlet 1400 ft from Des Plaines River ↕



Photos: from Huff& Huff, Inc., courtesy of Illinois Tollway

Specification Considerations

Subsurface drains used with RCA base material

- “Subsurface drain outlets shall not be located within 200 feet upstream of the eventual watercourse. This allows the necessary spacing for the construction of any biological treatment feature downstream from the outlet to treat fine material which may wash out from the RCA.”

Photo: Illinois Tollway

- “If th [illegible] feet from a watercourse, the designer shall allow space for a Mechanical Sedimentation Trap to be constructed to remove the RCA fines.”

Ongoing research
Alkaline runoff BMPs

Dr. Matthew Ginder-Vogel, PI

Goals:

1) Identify potential cause(s) of different findings between laboratory and field leaching studies
   - Forensic investigation on dismantled cells at MnRoad
   - Using "fresh" RCA, determine role of variable saturation, carbonation on leaching characteristics

2) Use of soils to mitigate pH/leachate concerns at RCA stockpiles and roadbeds
   - Clayey soils can neutralize high pH leachate
     - How long different types of soils will neutralize high pH leachate?
     - Develop reactive transport models
       - linking soil characteristics to leachate characteristics

Developing guidance on use of certain types of soils around stockpiles, detention basins, channels, roadbeds

Slurries and Washwater Handling

Best practices for washwater include:

– Washoff and disposal at designated area in open subgrade or shoulder
– Washoff at a designated area on a closed surface, then subsequent disposal
– Work area isolation, with subsequent capture and disposal
– Sump manhole isolation trap & vacuum removal

- Reduce wastewater production
- Use evaporative techniques where feasible

(Photo: Dwayne Stenlund, MnDOT)

Waste Handling and Disposal Options

Frac tank for settling solids (above),
lined slurry decanting pond (below)

- Feasible options vs. desirable options
- Beneficial Reuse vs. Disposal
  - Decisions driven by economics, risk aversion
  - Vary by project, state

- Many disposal options available
- Landfill, on-site burial
- Often fines buried alongside of road
- <u>Comply with applicable regulations</u>

Projects should be approached in a manner that gives the contractor options so recycling opportunities can be incorporated into the bidding process.

Beneficial Reuse of Fines

In some states, gradation in specs is wide enough all can be used as RCA, including fines

- Illinois DOT specifications for I-57 project
  - specifications were modified to allow RCA fines produced during crushing to be utilized
  - 20% natural sand allowed to help with workability
  - Impact crushers not allowed
  - Fines washed to remove minus #200 material (Rowden 2016)
- Colorado DOT I-25 project (2008) recycled 100% of original concrete
  - Crusher fines were used as pipe bedding (Prieve and Niculae 2016)
- Some research performed to see if RCA fines could serve as a "less than optimal internal curing agent," although not highly successful

Beneficial Reuse of Fines

TXDOT use of RCA fines in 5.8 miles of IH 10 (Naranjo 2016)

- 100% RCA, including fine RCA
- Workability reported to initially be an issue
  - Lack of moisture control of fine aggregate stockpiles
  - Contractor improved sprinkling of stockpiles, controlling moisture
- Section in service since 1998, good performance reported to date
- Specifications for TXDOT based on this section
  - Limit RCA fine aggregate to 20% of the fine aggregate blend

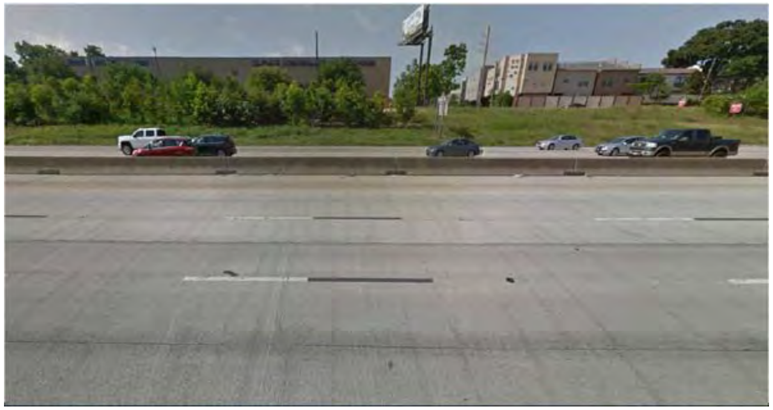


Photo: Naranjo, 2016

Beneficial Reuse of Fines

Use of Recycled Crushed Concrete (RCC) Fines for Soil Stabilization

- Tested virgin and lime-stabilized soils with and without additional RCA fines

- Addition of 3% RCA fines
  - did not change the amount of lime required for modification
  - was inert as either a stabilizer or a short-term modifier
- Use of RCC fines may provide a less-costly alternative solutions for subgrade stabilization
- Further cost savings
  - elimination of landfill tipping fees
- Field investigation suggested

(Linderman and Varilek 2016)

Nebraska Department of Roads

Waste concrete fines
(from Lindeman and Varilek 2016)

Environmental Considerations in Concrete Recycling

SUMMARY AND RECOMMENDATIONS

Summary

- Many states do not have environmental considerations for concrete recycling specifically incorporated into specifications or other regulations.
  - Concrete material sourced from an agency's own infrastructure for recycling is typically exempt from testing for environmental impact.

Existing BMPs
and
readily implementable design and construction controls
are generally effective
in preventing adverse environmental impacts of use of RCA.

- Multiple disposal and reuse options exist for RCA waste materials
  - Beneficial reuses should be enticing to owners to improve overall sustainability efforts.

Promoting Recycling
Regulatory Considerations

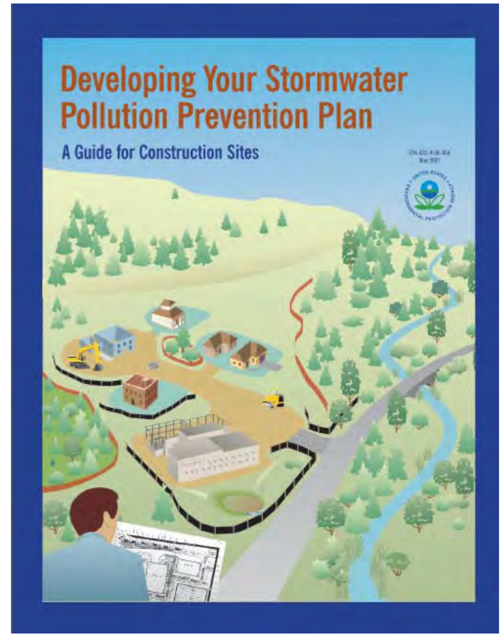
- Some regulations/categorizations of RCA can cause:
  - Delays
  - Expense
  - Risk (perceived or real
  - Decreased potential for recycling

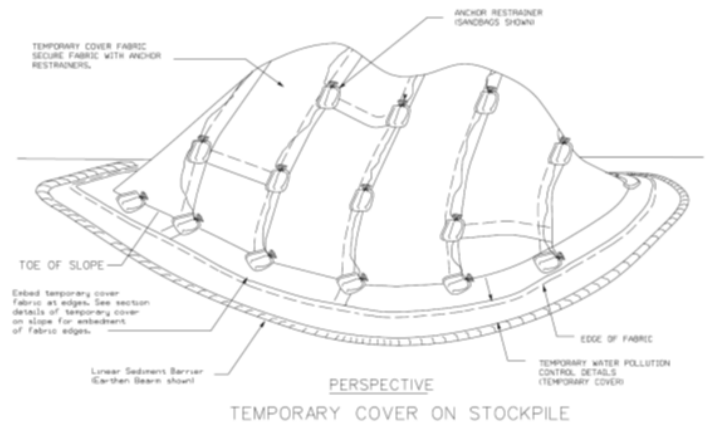
- Reducing regulatory burden can increase use of RCA
  - Legislation/compliance agreements related to waste definition(s) and practices
  - Guidance for allowable (and encouraged) recycling activities
  - Up-front guidance and "clear path" through regulation
    - Minimizes risk for contractor, can provide cost savings for Owner
  - Training of personnel

Training and Guidance

Address upfront prior to project start

- Developing Your Stormwater Pollution Prevention Plan (EPA 2007)
- Include details for BMPs for water/air pollution protection in project drawings or special provisions
- Pre-construction meetings and during construction meetings
- Integrate info on concrete recycling and mitigation of concerns into existing training courses and seminars for stormwater and erosion control





Source: MnDOT

Guidance Documents


Fugitive Dust Prevention Guidance: Control and Prevention During Construction Activities.

Given the right conditions, pavement rubblization practices are typically less dust prone than backhoe removal, truck loading, and hauling

BMP 4. Multihead pavement breaker rubblization. Water mists not need this day.

BMP 4. Guillotine pavement breaker rubblization. Water sprays not need this day.

BMP 4. Bituminous pavement grinding with appropriate water to cutter head (part of cooling system). Excellent dust control (TH65).

BMP 8. Hydro-deck demolition and cleaning in one operation, ready for concrete overlay . (TH35)

BMP 4. Small bituminous saw cutter with water tank injector application (I35W Frontage).

BMP 4. Mobile misting machine that can be tracked along with pavement demolition methods (TH35E).

BMP 8. Hydro-deck pavement demolition using AquaCutter system.

BMP 4/7. Rampart Hydro TracVac removals of shallow depth pavement removal.

BMP 4/5. Mobile panel wind and mist shroud for pavement demolitions.

BMP 4. Water spray application appropriate for dust generating activity (Light Rail).

BMP 4/7. Pavement hammer demolition with water mists and rubble vacuum removal (I35W).

Example Best Management Practices:

1. Develop location specific Dust Prevention Program[a,b]
   Over water, and On-land
2. Following 1717 Site Management and Quality Control Plans
3. Monitor wind speed and direction, with identified stop work process
4. Apply water mists and sprays at all appropriate material removal operations
5. Deploy wind shrouds
6. Use pre-wetting and resonant pavement rubblization methods
7. Use power-vacuum systems
8. Use hydro-demolition and power vacuum systems

[a]Follow diamond grinding guidance requirements

[b]See also Saw Cutting of deck, pavements and structures Guidance Series 4

REVISION: VERSION 1, 11/24/15
DEVELOPED BY: Dwayne Stenlund
Office of Environmental Stewardship

ADDITIONAL INFORMATION
DWAYNE STENLUND 612-810-9409
GWEN MEI 651-366-5802

PARTIAL AND FULL DEPTH PAVEMENT REMOVAL

FUGITIVE DUST PREVENTION BMP | BMP SERIES 14

Developed by Dwayne Stenlund, MnDOT

Environmental Considerations in Concrete Recycling

PRACTITIONER RESOURCES

Existing Resources

- ACPA EB043P
- CP Tech Center RCA Deployment Plan
- AASHTO M319-02 RCA in unbound base
- EPA Developing Your Stormwater Pollution Prevention Plan
- EPA BMP Concrete Washout
- OSHA website: https://www.osha.gov/silica/
- ACPA Technical Bulletin "Understanding OSHA's Crystalline Silica Rule"


A Technology Deployment Plan for the Use of Recycled Concrete Aggregates in Concrete Paving Mixtures

National Concrete Pavement Technology Center

Final Report
June 2011

IOWA STATE UNIVERSITY
Institute for Transportation

Resources in Development

FHWA Concrete Recycling Initiative:

- Practitioner's Manual: Recycled Concrete Aggregate – Guidance for Agencies, Consultants, and Contractors

- Tech Briefs
  – Mitigating Environmental Concerns for Concrete Pavement Recycling
  – Residuals Management for Concrete Pavement Recycling

Ongoing research reports:

– University of Wisconsin-Madison
  - "Chemical Characterization of Leachate Produced from RCA"

– George Mason University
  - "Suitability of Using Recycled Concrete Aggregate with Filter Geotextiles in Road Construction."

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- Maria Masten, MnDOT
- Jim Foringer, PennDOT District 11-0

Questions?

There appears to be no negative environmental effects from using RCA that significantly offset the positive environmental effect of reduced use of virgin aggregate and landfills

FHWA "Towards Sustainable Pavement Systems: A Reference Document," and Reiner 2008

But…

Recycling is inherently an environmentally beneficial practice, but must mitigate potential adverse impacts on the environment and human health

TABLE 1: SPECIFIED EXPOSURE CONTROL METHODS WHEN WORKING WITH MATERIALS CONTAINING CRYSTALLINE SILICA

Equipment / Task	Engineering and Work Practice Control Methods	Required Respiratory Protection and Minimum Assigned Protection Factor (APF)	
		≤ 4 hours /shift	> 4 hours /shift
Crushing machines	• Use equipment designed to deliver water spray or mist for dust suppression at crusher and other points where dust is generated (e.g., hoppers, conveyers, sieves/sizing or vibrating components, and discharge points). • Operate and maintain machine in accordance with manufacturer's instructions to minimize dust emissions. • Use a ventilated booth that provides fresh, climate-controlled air to the operator, or a remote control station.	None	None
Heavy equipment and utility vehicles used to abrade or fracture silica or used during demolition activities involving silica-containing materials	• Operate equipment from within an enclosed cab. • When employees outside of the cab are engaged in the task, apply water and/or dust suppressants as necessary to minimize dust emissions.	None None	None None

From: www.osha.gov and ACPA 2016

TABLE 1: SPECIFIED EXPOSURE CONTROL METHODS WHEN WORKING WITH MATERIALS CONTAINING CRYSTALLINE SILICA

Equipment / Task	Engineering and Work Practice Control Methods	Required Respiratory Protection and Minimum Assigned Protection Factor (APF)	
		≤ 4 hours /shift	> 4 hours /shift
Jackhammers and handheld powered chipping tools	• Use tool with water delivery system that supplies a continuous stream or spray of water at the point of impact (or)	When Used Outdoors	
		None	APF 10
		When Used Indoors or in Enclosed Areas	
		APF 10	APF 10
	• Operate equipment from within an enclosed cab. • When employees outside of the cab are engaged in the task, apply water and/or dust suppressants as necessary to minimize dust emissions.	When Used Outdoors	
		None	None
		When Used Indoors or in Enclosed Areas	
		None	None

From: www.osha.gov and ACPA 2016