UCT
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New Approaches to Utility Cut Pavement Repair: Keyhole Coring & Reinstatement

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Outline

- 2016 FHWA Best Practice Guide to Utility Cuts
- What is Keyhole Coring & Reinstatement ?
- Why Coring & Reinstatement is a Best Practice
- Problems with Conventional Utility Cuts
- Mechanics of Excavation:
  - Size, Shape, Cut and Repair Methods are Important
- Field Proven Repair Method – Zero Failures
- Keyhole Applications and Tools
- Environmental and Other Benefits
- Comparative Costs
- Standards and Incentives

2017 FHWA Best Practice Guide to Utility Cuts

The FHWA New Approaches to Utility Cut Pavement Repair

- FINDINGS: **Keyhole Coring is a Best Practice** that can minimize impact of utility cuts on both highway infrastructure and the traveling public.
- RECOMMENDATION: **Coring and Reinstatement process should be employed** by roadway agencies and utility companies.
- IMPLEMENTATION: circulate **Report, Tech Brief** and **Recommendations** to:
  - **50** State DOTs,
  - **384** Metropolitan Planning Organizations, and
  - **20,000** County and Municipal Roads departments
- SPONSOR **Webinars & Demonstrations** to encourage awareness and implementation under **Technology & Innovation Deployment Program**

Why Coring & Reinstatement is a BEST PRACTICE

- **Better for the pavement** — restores to pre-excavation design capacity
- **Safer for the workers** — no jackhammers, no trench work
- **Reduces public inconvenience** and traffic disruption
- **Faster, shorter road closings** — one step permanent pavement repair
- **Creates waterproof pavement repair** — no cracks or potholes
- **Aesthetically pleasing** — an almost invisible restoration
- **Better for the environment** — Reduced Carbon Footprint & VOCs
- **Re-uses/Recycles paving resources**
- **Field proven** — over 15 years with ZERO performance failures
- **Creates no pavement spoil** or disposal issues
- **Cost-effective** for the utilities and their contractors

What is Keyhole Coring & Reinstatement ?

Keyhole Coring
and
Core Reinstatement Process

What's wrong with Conventional Utility Cuts ?

- They settle and crack and result in a bumpy ride.
- They reduce performance life of the pavement.
- The sealant squeezes out allowing ground water to penetrate leading to premature pavement failure.
- They result in potholes that must be repaired over and over.
- They're ugly and don't match the rest of the pavement
- Road no longer performs as a load bearing system.
- The road may need replacement sooner.

Conventional Excavation Methods

- **Damage:** Saw cuts, jackhammers, and backhoes can result in destruction of underground facilities, pavement damage or worker injury.

- **Delays:** Road work and utility cuts cause 400 million hours of traffic delay and disruption and costs drivers $6 Billion in wasted time.
- **Reduced Worker Safety:** Higher risk of injury from jackhammers and trench work.

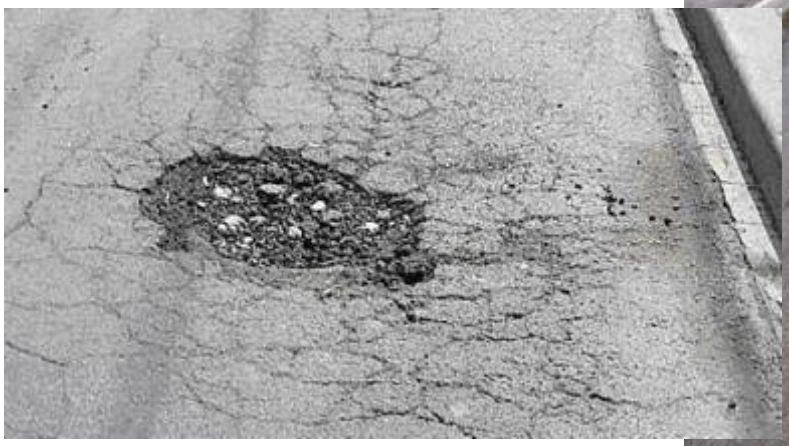
- **Spoils Disposal:** Need to truck tons of pavement spoils through city streets to waste disposal dumpsite.
- **Reduced Pavement Life Expectancy:** Conventional utility cuts in the roadway can increase damage to adjacent pavement and increase potential for groundwater penetration which can significantly reduce the life expectancy of roads.

Conventional Utility Cut Repairs






Resulting in Potholes.



They are also unsightly and dangerous

Keyhole Technology is a Better Way

- A **minimally invasive method** of accessing or viewing underground utilities through small holes or “keyholes” that are vacuum excavated through soft surfaces or through holes cut or cored through pavement.

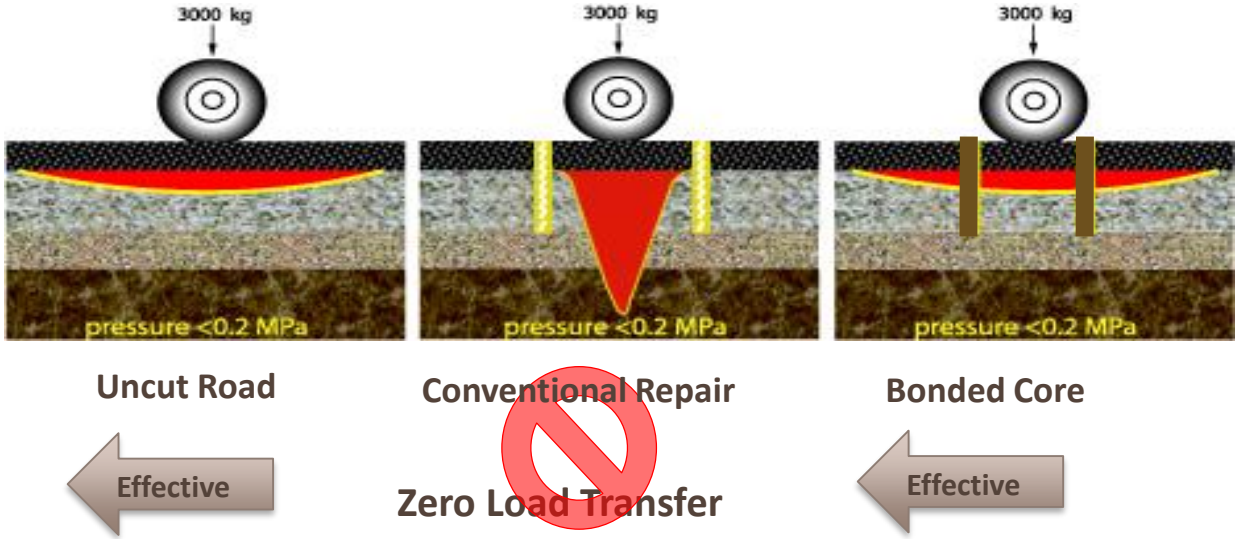
Keyhole Cuts Mean Better Pavement Performance

- **Same Pavement Profile** and **Appearance**

Perfect Match: The reinstated core is a perfect match of profile, texture and color of the surrounding pavement … *it was cut from that pavement.*

- **Restores Load Transfer Capacity to Repaired Roadway**

Mechanical Joint: Utilibond bonding compound creates a mechanical joint with the remaining pavement to restore its load transfer capability to what it was prior to the excavation.



Shorter Road Closures Mean Better Public Relations

- **Shorter Road Closure:** Road can be safely reopened to traffic within 30 minutes of reinstatement as a **Permanent Repair.**
- **In and out the same day.** No need for further road closings for subsequent permanent pavement repair.

Single Road Closure

Greatly Improved Aesthetics

Final Repair

Basic Mechanics of Excavation & Repair

- **Size:** Smaller is better
- **Shape:** Rectangular cuts are a problem – Corner Cracks
- **Cut Method:** How you cut is important – Low Impact
- **Repair Method:** Waterproof joint, restores load transfer ability, aesthetically pleasing

Smaller is Better

- **Surgeons know that smaller is better and less intrusive**

Keyhole Operation

Laparoscopic Surgery

- Smaller Incision
- Short Recovery Period
- Faster Healing
- Smaller Scar
- Lower Cost

Smaller is Better

- **The same is true for Utility Cuts**

Laparoscopic Surgery

- Smaller Incision
- Short Recovery Period
- Faster Healing
- Smaller Scar
- Lower Cost

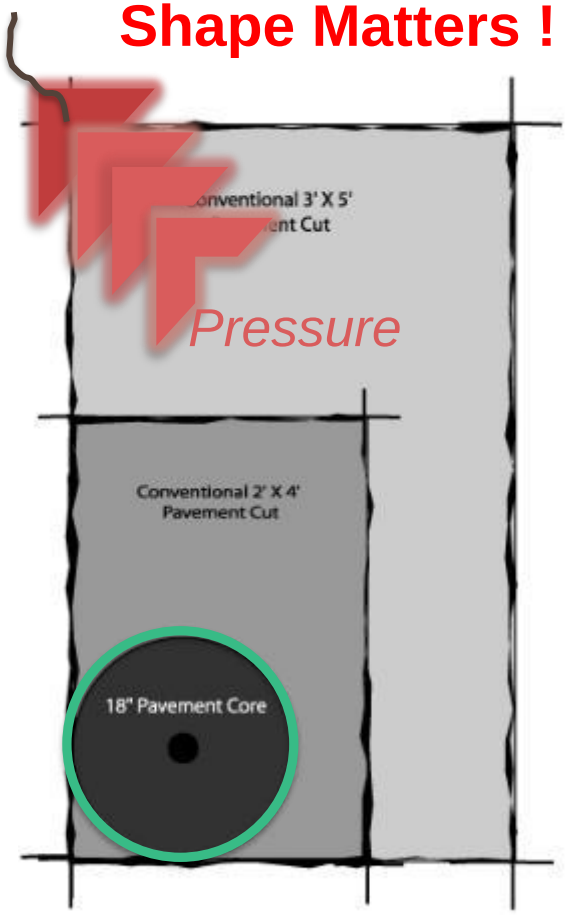
Keyhole Operation

- Smaller Opening (keyhole)
- Faster Restoration
- Less Damage to Road System
- Smaller Repair Footprint
- Lower Cost

✪ **and safer -- no men in the hole**

Circular Shape is Better

Shape Matters !

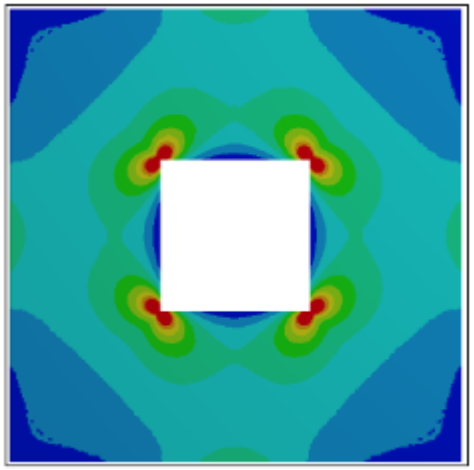


Waterproof and No Corner Cracks

- **Smaller Circular Shape – More Precise Excavation**
  - – Waterproof: No saw over-cuts at the corners
  - – Environmentally friendly, reuses materials, creates no spoils and no VOCs
  - – Reduced surface scarring -- 10 to 20 times SMALLER than conventional restoration (1.75 ft^2 vs 24 ft^2 to 35ft^2)
  - – Circular geometry with no corner cracks
- **Proven Strength -- NO Failures**

  Reinstated core will support 50,000 lbs wheel load
- **Better Performance -- Reduced Delay**
  - – Reduced pavement deterioration -- no potholes
  - – Reduced traffic delay -- no additional road closing for repaving … In and Out the same day.
  - – Aesthetically pleasing – perfect surface match -- invisible
- **Reduces Pavement Restoration Cost - 87%**
- **Safer for Workers and Public**

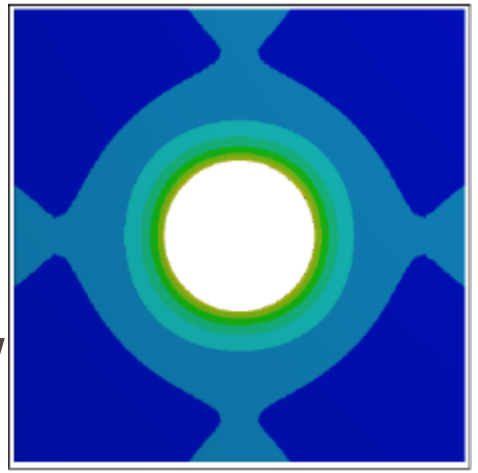
Traffic Pressure = Corner Cracks



A **RECTANGULAR** structure has

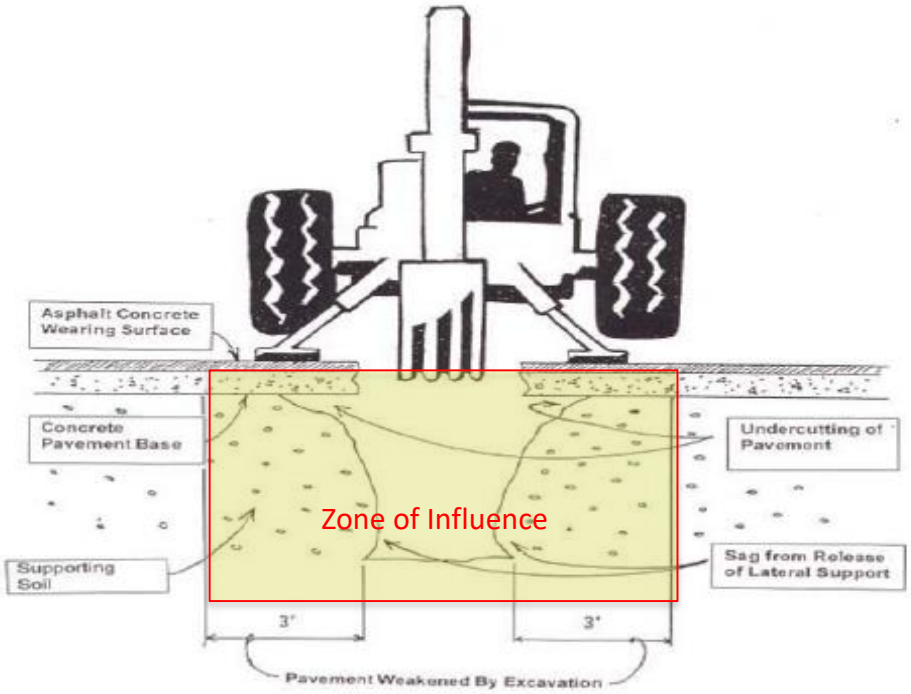
FOUR TIMES MORE

Traffic Pressure in corners than **CIRCULAR** format, causing corner pressure cracks that allow ground water penetration.



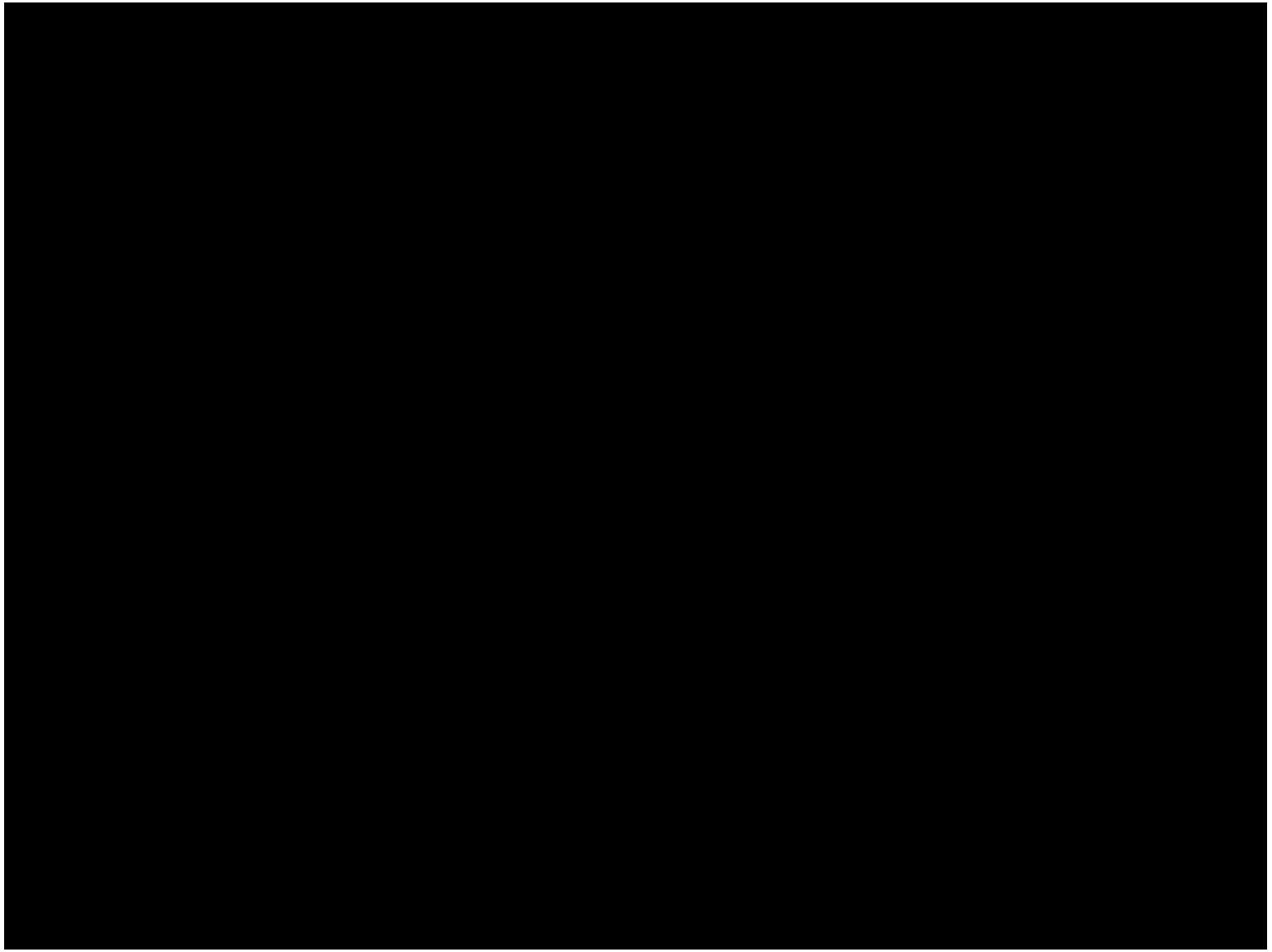
How You Cut is Important.

- **Conventional excavation** (Jackhammer, Backhoe, Pavement Breaker) **weakens pavement well beyond the cut** causing subsidence in “Zone of Influence”
- **Precise coring operation eliminates Zone of Influence and reduces pavement damage**



The precise coring process and vacuum excavation **eliminates any “Zone of Influence”.**

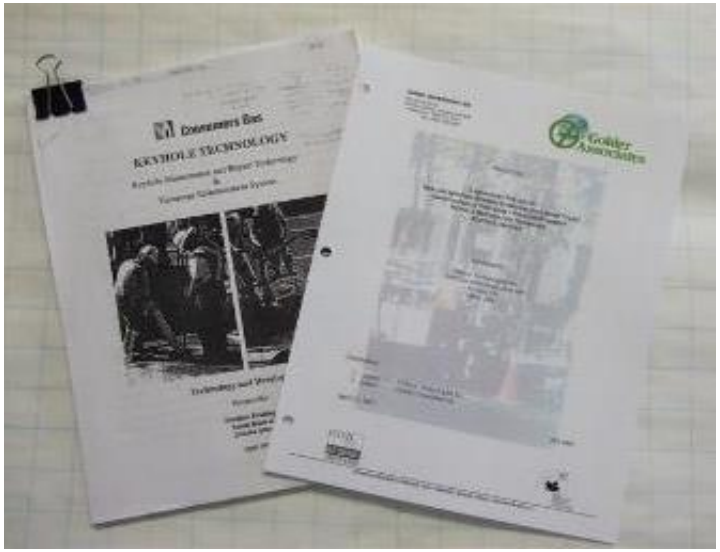
Reduced Road Damage



Proven Repair Method

Golder Associates 10 year Engineering Study (1992-2002):

FINDINGS:



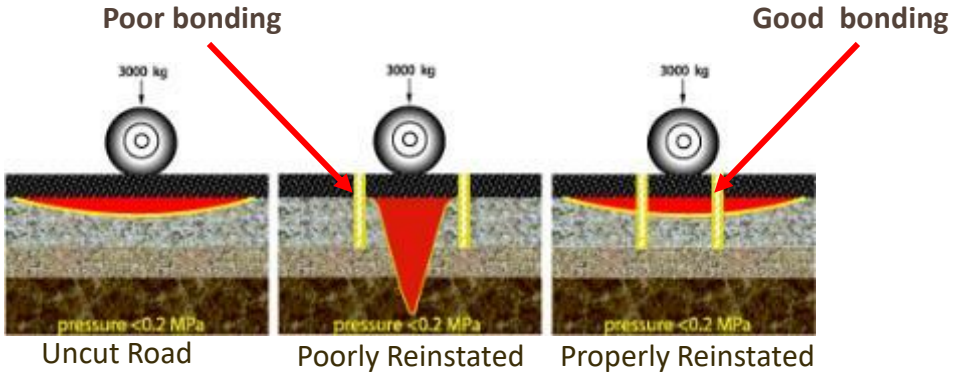
Golder Associates Engineering Reports 1996 and 2003

- **"Reinstated core reunites pavement sections with mechanical waterproof joint."**
  - No sealants to squeeze out with action of traffic
  - No ground water penetration
- **"Restores horizontal load transfer capability of pavement system."**

- "Based on trials and testing we are satisfied that Process will ensure **satisfactory long term performance of the pavement reinstatement."** **Golder Associates 2003**

Golder Report Testing & Results

Comprehensive Laboratory Testing



Effective Load Transfer

Fast Setting, Rapid Strength Gain, Convenient, Consistent, and Repeatable

Long-Term Performance through freeze-thaw cycles

Mechanical Bond
No Voids

Restoration of Utility Cut Study (2000-2005)

Joint Project of 20 North American Cities and States, 7 utility companies, AGA and GTI to develop best restoration practice based on sound engineering principles

Toronto Field Experiment: Observations

CONVENTIONAL TRENCH

- **Noticeable failures** in conventional cut.
- Conventionally repaired **joint between road and the cut opened.**
- Visible **settlement in trench** along wheel path.
- **Joint seal material lost** under action of traffic.
- Sand cover at base of trench exposed to **higher than normal levels of moisture** (compared with keyhole).

ROTARY CUT KEYHOLE

- **No defects** in keyhole cut.
- Keyhole section established Oct. 2001 **continued to perform well** throughout life of project.
- **Surface remained level** with the road.
- The **bonding material remained intact** (no cracking or separation.
- **Created waterproof joint.**

Findings & Conclusions:
Minimally Invasive Keyhole Utility Cuts

- **No Distress:** The keyhole restored October 2001 showed **no distress over 2 years** during the inspections performed during the May 2002 and April 2003 visits. The grout remained intact and the surface is level with the road.
- **Level -- No separation:** The surface of the restored keyhole remained at level with the road profile. The grout [Utilibond] surrounding the AC/PCC plug remained intact (no cracking or separation).
- **Lower Stress Levels:** The keyhole opening is quite small (18 in., 457 mm, in diameter) compared with the area of a tire print of heavy trucks in contact with the road surface. As a result, **low stresses are transmitted to the underlying sections of the restored keyhole**.
- **No Pressure Cracks:** Based on basic rules of mechanics, a **circular cut shape in the AC is ideal for preventing propagation of cracks into the surrounding road area.**

Conclusion: "The keyhole construction and restoration technique should be encouraged whenever feasible to minimize the need for opening large trenches in the future."

APWA Supports Use of Keyhole Technology

Report of Engineering and Technology Committee Utility and Public Right of Way Committee (2007)

"When practical, APWA supports the use of minimally invasive keyhole technology **to facilitate utility exposure or daylighting**."

"Keyhole technology has been **primarily used by the natural gas industry but this technology has the potential for being utilized on drinking water pipelines and service lines**."

"Keyhole technology also has the potential to be used by government agencies for **subsurface utility engineering on urban reconstruction projects.**"

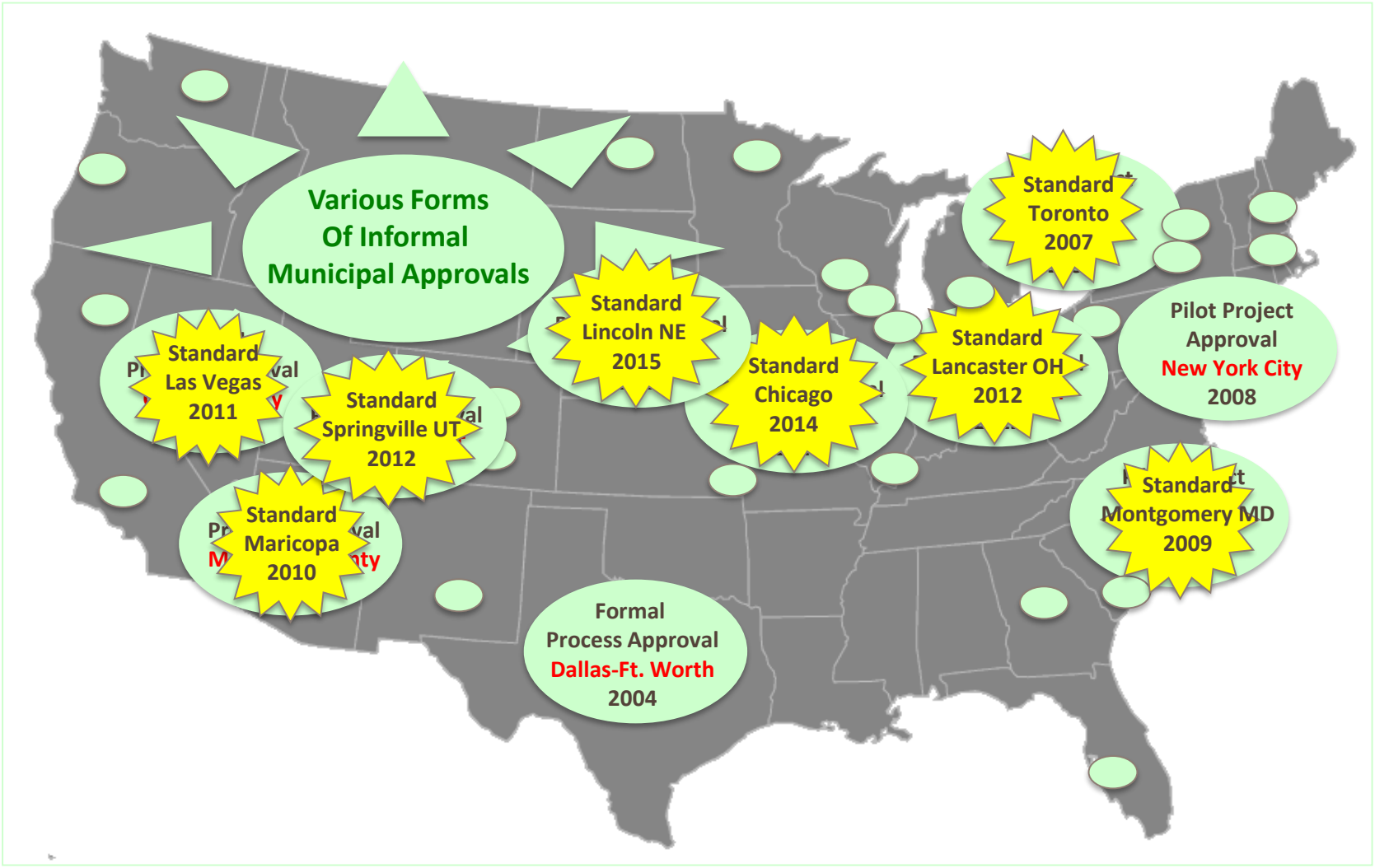
Accepted and Approved by Municipalities

Keyhole coring and reinstatement has been **ACCEPTED and APPROVED** as the **"Better Way"** by dozens of municipalities across North America.

New York City DOT Officials, March 9th, 2006

- **"… no jack-hammering to disrupt or damage the roadbed** or the rest of the pavement and it is **much quieter** than other methods." **NYC DOT Commissioner.**
- "It **cuts the time on the road**. That means **less inconvenience to the public**, which to a government agency responsible to the public like us, is **very important** !" **NYC DOT Commissioner**
- "I like the smaller, circular hole and the fact that it **allows you to reopen the road to traffic within 30 minutes** of the repair." **NYC DOT Commissioner**

Municipal Standards & Regulation

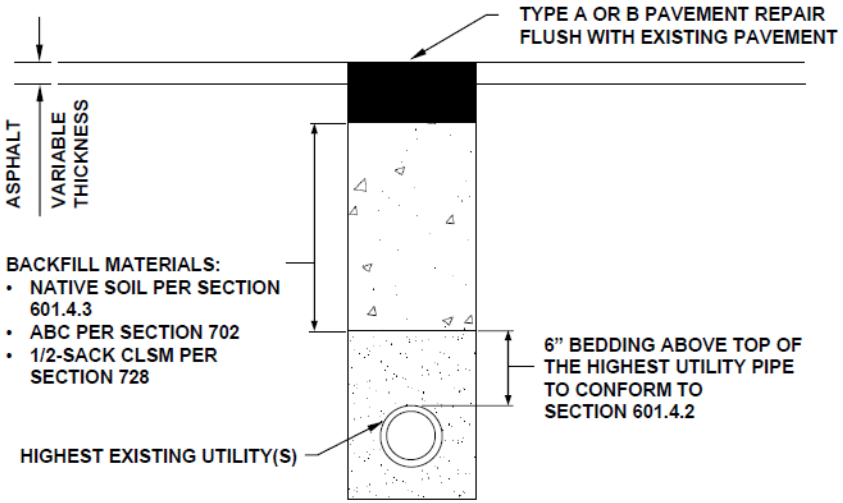


Regional Transportation Commission of Southern Nevada

NEW STANDARD SPECIFICATION: **Section 215 "Keyhole Pothole Excavation and Backfill"** to allow for Keyhole Type Pothole Excavation and Repair – effective January 1st, 2011

215.01 Keyhole coring: The operation of coring a circular hole through the roadway pavement using diamond core drilling equipment.

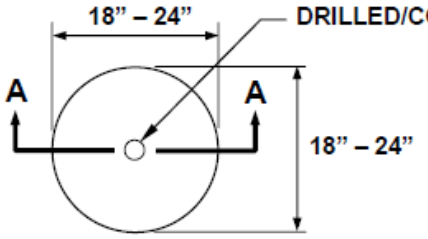
Pavement Restoration The surface cut by keyhole coring to be restored flush with existing surface, matching existing pavement appearance … with gaps attributable to the positioning of the core less than 1/16-inch.



SECTION VIEW

NOTES:

1. CUT, REMOVE AND REPLACE PAVEMENT PLUG IN ACCORDANCE WITH SECTION 355.
2. PLACE BACKFILL IN ACCORDANCE WITH SECTION 355.
3. BONDING MATERIAL SHALL BE AS SPECIFIED IN SECTION 708.



PLAN VIEW

Advantages for the Municipality & Public

- **Improved Appearance.** Almost invisible, matching circular core -- less than 1/10 the size of conventional road cut).
- **Reduced Damage** to the Pavement. Road restored to original design specification. No sunken patches or weakened or failed roads. ***No Potholes***.
- **Cleaner, Safer, Less Intrusive** Worksite:
  - No jack-hammers or large excavation equipment
  - Less noise and mess and reduced disruption for neighbors
  - No spoil trucked through city.
- **Fewer Complaints** from Public.
- **Reduced Traffic Disruption**
- **Improved Logistics:** Restoration is immediate. Reopen road to traffic in 30 min.

Keyhole Applications

- **Expose Underground Facilities and/or Perform Necessary Work**

Installing Temporary Road Plate

Locating

Potholing for HDD – Damage Prevention

- **About 80% keyholes are for inspection purposes only: HDD, S.U.E.**
- **Photo Right: Potholing to expose conflicts when HDD crosses street**
- **Circular road plates allow at least 2 lanes of traffic to remain open**

Keyhole Tools

- All tooling is designed with longer handles to allow for use from above ground

Valve Maintenance

New Approaches for Water Service Replacement

City of Des Moines Water Dept.

Corrosion protection

- City of Des Moines Water Department utilizing Keyhole Technology to cathodically protect their water mains
  - Coring the pavement
  - Using long-handled brazing tool to install anodes
  - Result – reduction in cracked mains

Keyhole – A Growing Trend

- More and more utilities (Gas and Water) are now requiring work to be performed through keyholes.

Comparative Costs

Cost to Cut and Repair 2 ft² Opening in Asphalt Pavement 6" Thick

Asphalt Pavement (6")	Coring	Conventional
Pavement Opening	Core: (20 minutes): $50 (2 men & truck = $150/hr.) **Total: $50**	Saw Cut (20 minutes) $50 Jack Hammer (30 minutes) $75 Haul & Dispose Spoil $85 **Total: $210**
Vacuum & Backfill	Equal	Equal
Restoration	**Reinstate Core** Utilibond (pail) $75 2 men & truck for 1 hr. = $150 (Includes waiting 30 minutes to reopen road to traffic) **Total: $225**	**Temporary Cold Patch:** $75 Maintenance: $75 **Sub Total: $150** **Permanent Repair** • Cut Back & Disposal: $195 • Repave 4x4 (@ $15 ft² = $240 **Sub Total: $425** **Total: $575**
Total Cut & Restore	**$275**	**$785**

Comparative Costs

Cost to Cut and Repair 2 ft^2 Opening in Composite Pavement 10”Thick

Composite Pavement (10”)	Coring	Conventional
Pavement Opening	Core: (20 minutes): $50 (2 men & truck = $150/hr.) **Total: $50**	Saw Cut (20 minutes) $50 Jack Hammer (45 minutes) $115 Haul & Dispose Spoil $125 **Total: $290**
Vacuum & Backfill	Equal	Equal
Restoration	**Reinstate Core** Utilibond (pail) $75 2 men & truck for 1 hr. = $150 (Includes waiting 30 minutes to reopen road to traffic) **Total: $225**	**Temporary Cold Patch:** $75 Maintenance: $75 **Sub Total: $150** **Permanent Repair** • Cut Back & Disposal: $195 • Replace Concrete: $400 • Repave Asphalt 4x4: $240 **Sub Total: $835** **Total: $985**
Total Cut & Restore	**$275**	**$1,275**

Comparative Costs

Cost to Cut and Repair 2 ft² Opening in Concrete Sidewalk 4" Thick

Concrete Sidewalk Bay (4")	Coring	Conventional
Pavement Opening	Core: (15 minutes): $40 (2 men & truck = $150/hr.) **Total: $40**	Saw Cut (20 minutes) $50 Jack Hammer (30 minutes) $75 Haul & Dispose Spoil $85 **Total: $210**
Vacuum & Backfill	Equal	Equal
Restoration **NOTE:** Many municipalities require replacement of all sidewalk panels -- from expansion joint to expansion joint.	**Reinstate Core** Utilibond (pail) $75 2 men & truck for 1 hr. = $150 (Includes waiting 30 minutes to reopen road to traffic) **Total: $225**	**Temporary Cold Patch:** $75 Maintenance: $75 **Sub Total: $150** **Permanent Repair** Replace 1 Panel: $500 Replace 3 Panels: $1,500 **Sub Total: $500 or $1,500** **Total: $650 or $1,650**
Total Cut & Restore	**$265**	**$860 or $1,860**

Reduced Carbon Footprint

Coring

1

Excavation

Core

Vacuum

Same Day

Restoration

Reinstate

Finished Repair

Conventional

1

Saw Cut

Excavate Pavement

Dump Spoil

Vacuum

Temporary Asphalt Patch

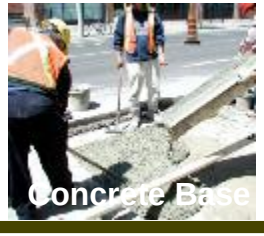
Compact Patch

Months Later

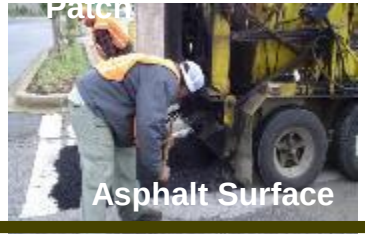
2

Excavate Patch

Dump Spoil



Concrete Base



Asphalt Surface

Compact Surface

Reduced Carbon Footprint

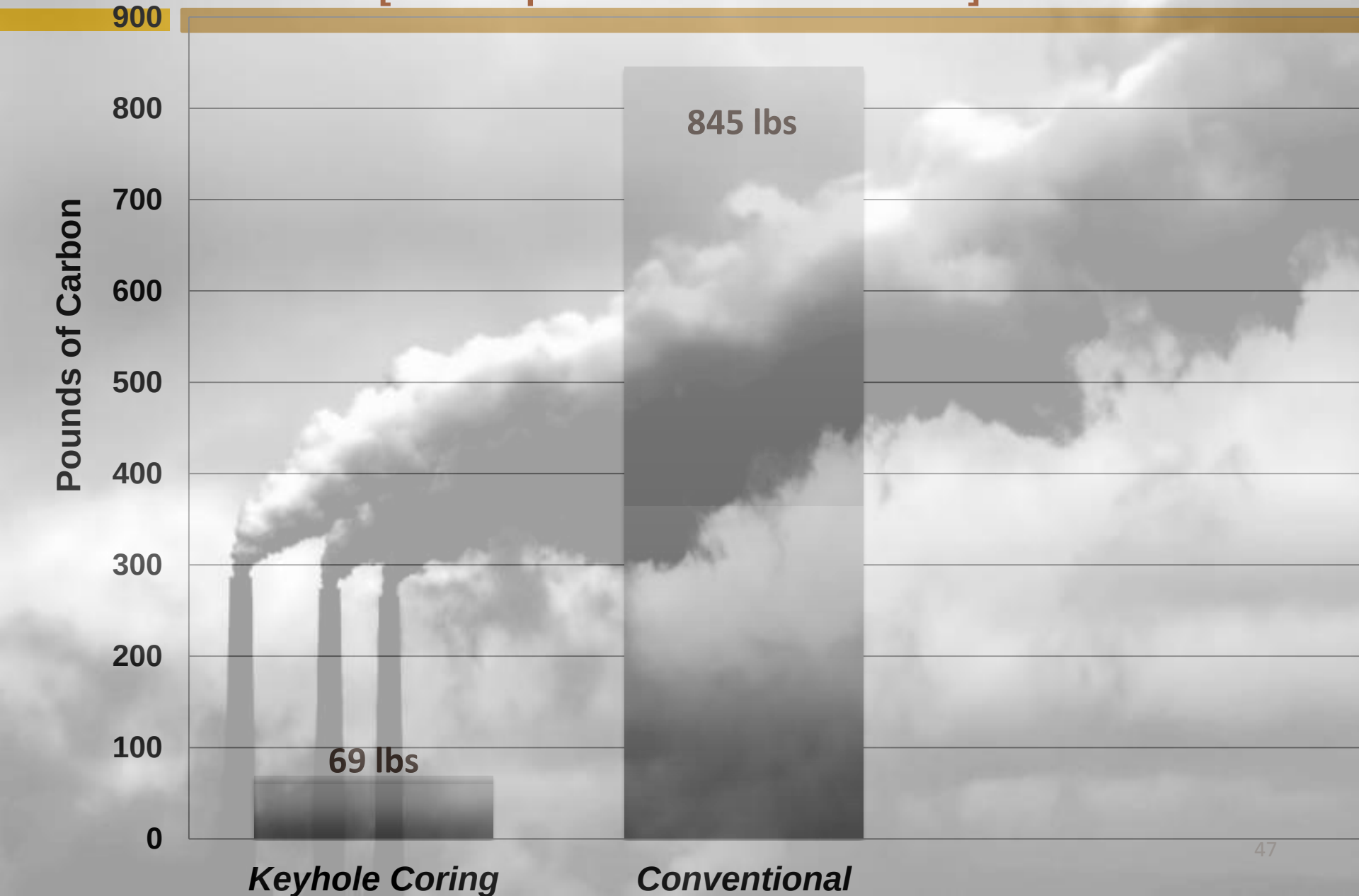
- Coring and Reinstatement has an **OPERATING CARBON FOOTPRINT ONE-SIXTH** the size of conventional excavation and restoration methods (60 lbs vs 365 lbs)

  BUT if you add the CO_2 emitted in the production of the cement products used in each of the repairs

- **TOTAL CARBON FOOTPRINT** of the Keyhole Coring & Repair is **ONE-TWELFTH** the size of conventional method (69 lbs vs 845 lbs)

CO_2 Greenhouse Gas Emissions

[From Operations & Manufacture]



3.6 million Utility Cut Permits
(issued by municipalities every year)

Environmental Impact of Coring

- **20-25% of utility cuts can be small holes** (Gas Technology Institute)
- If 800,000 small hole utility cuts in USA were performed with keyhole coring and reinstatement:

Reduction in asphalt used: **2 million tons**

-- enough to resurface 650 miles of 4 lane highway

Reduction in spoil disposal: **27 million cu. ft.**

-- enough to fill 200,000 dump trucks

Reduction in work zone delay: **2.8 million hours**

1.9 million gal fuel

$520 million cost

Restoration Cost Savings to Utilities: **$340 to $900 million**

Reduction in GHG emissions: **320,000 Tons of GHG Emissions**

≈ equal to CO_2 emissions from Average Power Plant (2.8 billion tons CO_2 ÷ 8000 power plants)

Promoting Use of Keyhole Coring & Reinstatement

Methods of encouraging the adoption of the process by municipalities.

- **Education:**
  - Dissemination of FHWA Best Practice Guide and Tech Brief
  - Webinars and Regional Demonstrations
- **Incentives:**
  - Waiver of requirements for more costly pavement treatments like cut backs, slurry treatments, mill and overlay
  - Permission to use Coring & Reinstatement on protected pavements
  - Waiver or reduced degradation fees
  - Waiver or reduced security deposits.
  - Simplified permitting procedures
- **Disincentives:**
  - Restoration disincentives for more disruptive/destructive excavation and restoration processes

Summary – Keyhole Coring Advantages

- **Precise Coring – No Heavy Equipment**
  - No Zone of Influence
  - Easier on the back of workers
- **No Pressure Corner Cracks or Saw Over-Cuts**
  - No ground water penetration
- **Restores Load Transfer Capability of Pavement System**
- **Reunites Pavement Sections with Mechanical Waterproof Joint**
  - No sealants that can squeeze out with action of traffic needed
  - No ground water penetration
- **Environmentally Friendly – Consumes Fewer Resources**
  - Reuses original pavement core – no spoil to truck away – no new paving materials required.
  - No VOCs to escape -- 1/12 Carbon Footprint of conventional methods
- **Reduced Public Inconvenience – Aesthetically Pleasing – Cost Effective**
  - Shorter and fewer road closings -- Reduced traffic delays
  - Saves money for Taxpayer/Ratepayer/Contractor/Utility.

Questions and Answers

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