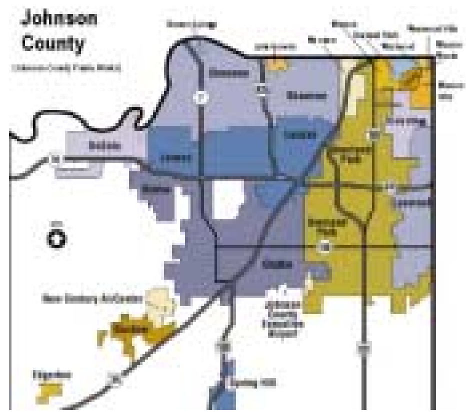
Johnson County Concrete Board (JCCB) Web Site Helps Public Works Officials Standardize Quality Concrete in Johnson County

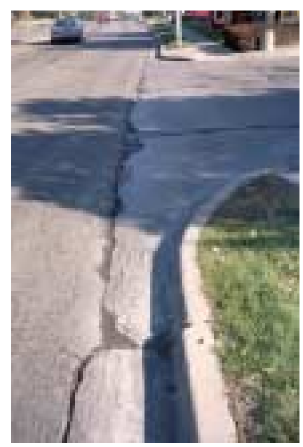
History



The Johnson County Concrete Board (JCCB) is a cooperative effort of municipal and county public works officials whose goal is to standardize the use of improved concrete technology by developing specifications and to simplify the concrete mix design approval process via a new web site. The JCCB originated in the City/Concrete Industry Work Group of Johnson County, Kansas, an informal organization that brings together public works professionals, concrete suppliers, and representatives of related associations to share information. Concerned about the quality of concrete used in projects in Johnson County, members of the Work Group set out to discover and prevent the causes of premature cracking and deterioration in a wide variety of applications such as pavement, bridges, sidewalks, curb and gutter, and storm drainage inlets.

Preventing Premature Deterioration

Public works officials in the Kansas City metropolitan area – including Johnson County – have experienced problems with the premature failure of concrete. The problem has been labeled "D-Cracking" and is caused by the crumbling of the large aggregate in the concrete mix due to moisture and freeze/thaw cycles. Midwestern winter weather is among the most severe in its effect on concrete structures and pavements. Winter moisture in the form of rain, freezing rain, sleet, and snow combined with temperatures that fluctuate above and below freezing can cause significant damage. Area studies have proven that this D-cracking problem is caused by the locally produced limestone aggregates. The most cost-effective solution to the problem was determined to be to modify the concrete aggregate specification to include more durable non-local aggregates. (A detailed report is located in the Appendix for reference.)



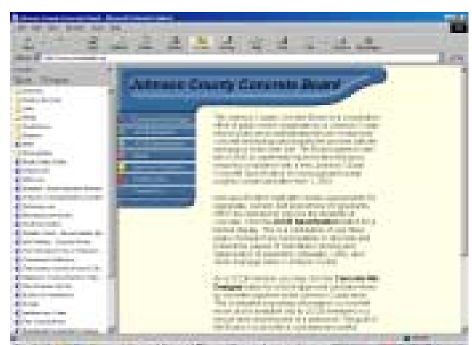
Alkali-Silica Reactivity (ASR)

Eliminating the limestone from concrete, however, increased the potential for Alkali-Silica Reactivity (ASR). Engineers increasingly recognize ASR as a serious problem. According to an article in the January 2002 issue of *CE News*, "ASR has the potential to impact any concrete structure in any state." ASR is caused by reactive aggregates that compromise durability, allowing day-to-day wear-and-tear to become prematurely destructive. The article goes on to say that careful aggregate specification and use of admixtures can suppress ASR damage. "The best way to avoid ASR in new concrete is to take precautions in the mix design."

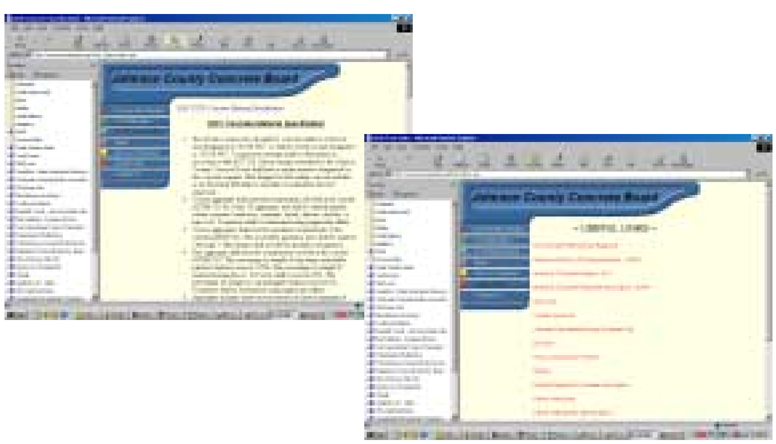
Standard Concrete Specification Adopted

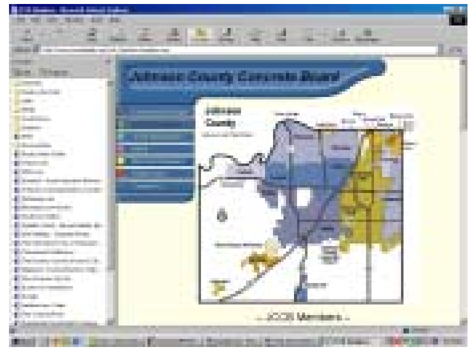
After studying various concrete mixes, members of the City/Concrete Industry Work Group agreed to develop a standard concrete specification. The JCCB specification is a culmination of more than three years of concrete research. During a meeting in January of 2000, a draft of the specification was presented for discussion (Please see "JCCB Minutes" tab). Comments from all member organizations were considered before the final specification was adopted. The new JCCB-approved specification became effective for municipal and county projects constructed after April 1, 2001. The JCCB continues to meet quarterly to address specification issues and recent advances in concrete technology.

Web Site Developed



The JCCB selected George Butler Associates, Inc. (GBA), a private Johnson County-based engineering and architectural firm, to develop this new web site to help JCCB members (public works officials only) ensure that area projects are using improved specifications for durable concrete. During start-up, GBA's Web Services Group established the site on the Internet. Located at **www.jocomaterials.org**, the site now contains 13 JCCB-approved concrete suppliers and more than 70 approved mix designs.





It is available 24 hours a day, seven days a week, to public works officials, inspectors, suppliers, contractors, and consultants. GBA maintains the web site and reviews concrete mix design submittals for compliance with a JCCB-approved specification. Hits have averaged 4,000 to 8,000 per month and have come from as far away as Taiwan, the United Kingdom, and the Netherlands. (Please see "Web Site Tour" tab.)

Member Benefits

JCCB members pay an annual fee to access approved concrete mix submittals on the web site. This detailed, proprietary information is available in a secure area requiring a member password. The site also includes pages set up for contractors, consultants, and approved suppliers, with links to member web sites as well as to other related sites. JCCB-approved specifications are updated annually to reflect improvements recommended by members and by the City/Concrete Industry Work Group. The new 2002 Concrete Materials Specification is now available on the site.

JCCB Looks to the Future

With the success of the web site, the JCCB has accomplished its goal. This consistently useful web site makes city/county acceptance of a supplier's concrete mix a matter of comparing the mix used to a list of accepted mix designs. It also provides guidance to inspectors on how to verify compliance at the job site. JCCB, with this web site, has made the concrete approval process faster and created a specification for durable concrete in Johnson County. The success of the JCCB has prompted public works officials to consider developing a similar database for standardizing and improving asphalt mixes used in Johnson County projects.

City of Overland Park
Public Works Department

Durable Concrete

A report on the durability of existing aggregates, and recommendations for changes to specifications and ordinances relating to concrete

Summary:

Beginning in 1984, Overland Park began requiring the use of coarse aggregates for concrete that met KDOT's durability class 1 or 6. Kansas has been studying the freeze-thaw durability characteristics of aggregates for decades. They have been successful in identifying those characteristics of rock which contribute to its early failure when subjected to repeated freeze-thaw cycles, and thus have been able to identify those aggregates which are most resistant to damage from freeze-thaw. Kansas published the results of their work and began using durable aggregates for highway construction over 10 years ago. Overland Park followed suit in 1984 in hopes of extending the life of concrete used for roads and structures. Curb inspections were added to Overland Park's annual pavement inspections (PAVER) in 1994. By comparing construction dates of streets with those curbs exhibiting durability related distresses in the PAVER inspections, staff was able to determine that many of the curbs constructed since 1985 are showing early signs of failure related to non-durable aggregates, despite using the KDOT durable aggregates. Staff and the Concrete Promotional Group (CPG) began a series of meetings several years ago to exchange information regarding the use of

concrete. CPG agreed to fund a set of aggregate tests provided the City funded a corroborative set of tests to investigate the feasibility of using non-local coarse aggregates. This report presents a new interim specification for concrete aggregates based upon the preliminary findings of those tests. We believe that this change will eliminate concrete problems relating to freeze-thaw durability.

***Freezing and thawing*:**

Mid-western winter weather is among the most severe for concrete structures and pavements. Winter moisture in the form of rain, freezing rain, sleet, and snow combine with saturated earth and temperatures which alternately dip above and below freezing to cause damage. The mechanical force exerted by water as it freezes in the pores of the material damages moisture-absorbing concrete. Thawing allows additional water to enter the enlarged pore spaces that are then frozen and enlarged further during the next freeze cycle. The bond between cement and aggregate can be broken by successive cycles producing rubble out of once strong concrete. The use of salt as a deicer aggravates the deterioration of reinforced concrete by also attacking the steel embedded within the concrete. As steel corrodes it swells with enough force to fracture the concrete surrounding the steel leaving the slab more and more vulnerable to further damage.

A freeze thaw cycle is one freeze followed by one thaw. The following table lists freeze-thaw cycles through the thirty year period beginning January of 1961 through December of 1990 for the Kansas City area. These results were compiled from hourly weather records from Solar and Meteorological Surface Observation Network, National Oceanic and Atmospheric Administration for Topeka, Kansas. Among other meteorological data, this source lists hourly temperature and rainfall, and notes other weather events. The "Degrees times hours" column is an indicator of the temperature mass of the freeze or thaw. As an example, 25 could represent a drop in temperature of 5 degrees below zero (Celsius) for 5 hours. The last column shows the total number of freeze-thaw events that were within 24 hours of a recorded precipitation event. Past research indicates that the freeze-thaw damage begins at the bottom of the concrete and works its way to the surface. Because subgrade moisture is present at or near saturation levels during the winter months, surface precipitation may be irrelevant. The heat mass represented by column one does need to be sufficient to freeze or thaw the pavement at the subgrade.

• Table 1- Freeze /Thaw Cycles (30 years)

Degrees times hours	Number of FT cycles	Number of Cycles following precip.
10	1250	354
25	855	276
50	578	226

If one were to design concrete for a fifty year life, a relatively conservative design would need to tolerate 855 cycles/30 years * 50 years = 1425 freeze/thaw cycles, a less conservative design life might tolerate 578 cycles/30 years * 50 years = 963 freeze-thaw cycles. Most aggregate testing examines the results of 50 freeze-thaw cycles; cast concrete specimens are tested by some procedures for as many as 350 freeze/thaw cycles. Note that a 350-cycle freeze thaw test could take as many as 350 working days to complete. From the foregoing, neither 50 cycles nor 350 cycles are representative of what may occur to a slab of concrete over a 50 year design life. One approach to concrete design might be to be intolerant of any materials that showed any signs of distress in any of the standardized freeze/thaw tests.

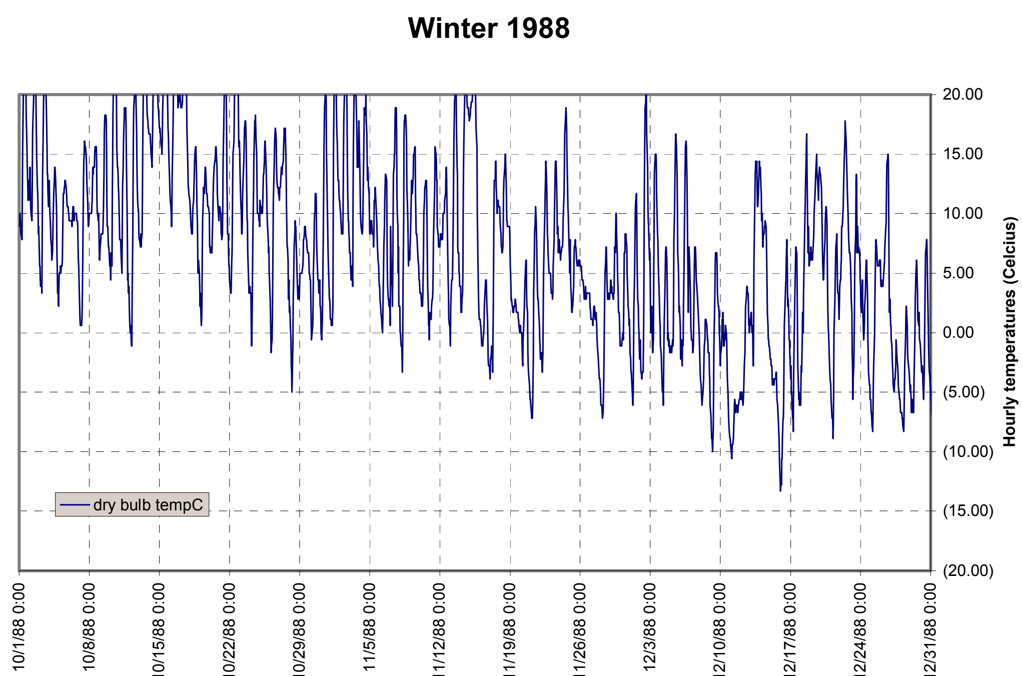


Figure 1 - Hourly Temperature Plot

Aggregates

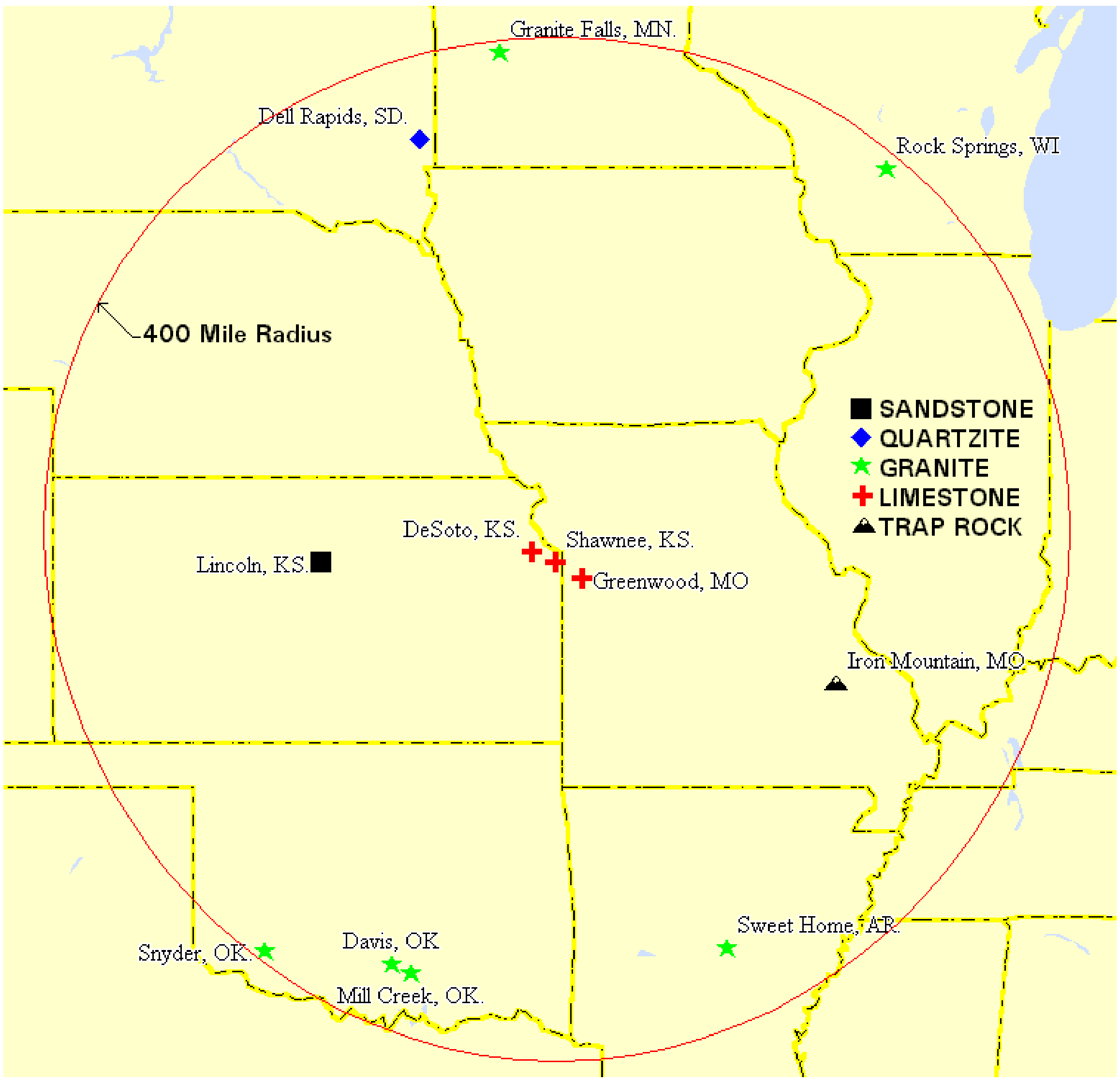
Coarse aggregate samples were obtained from several quarries all within 400 miles of the Kansas City metropolitan area. They represent a variety of geological types. Igneous samples include the granites from Oklahoma, Minnesota and Wisconsin, nepheline from Arkansas, and trap rock from Missouri. The quartzite from South Dakota is a metamorphic rock. All of the limestones and the sandstone from Lincoln, Kansas are sedimentary. Note that the sandstone comes from a company named Quartzite Stone, and is often referred to as quartzite. These samples do not represent every producer of rock within a 400-mile radius; rather they demonstrate that there are a variety of producers within that area. The map below shows the location of the quarries shown in the table. Kansas City, Missouri currently specifies and uses concrete that requires trap rock. The trap rock sample used in our tests came from a producer that has supplied concrete for Kansas City projects. The following table lists the aggregates tested by the CPG and by Overland Park. Note that several local limestone samples were added by the CPG, and were not included in the group being tested by Terracon for the City.

- **Table 2 Aggregate Samples**

Aggregate, Source, Location	Ash Grove ID
Limestone C-33 Commercial, Hunt Midwest, DeSoto, KS.	S-970578
Limestone KDOT Class 1, Shawnee Rock, Shawnee, KS.	S-970579
Sandstone, Quartzite Stone, Lincoln, KS.	S-970580
Granite, Granite Mountain Quarries, Sweet Home, AR.	S-970581
Granite, Meridian Aggregates, Snyder, OK.	S-970582
Granite, Meridian Aggregates, Mill Creek, OK.	S-970583
Granite, Meridian Aggregates, Granite Falls, MN.	S-970584
Granite, Western Rock Products, Davis, OK.	S-970585
Trap Rock, Iron Mountain, MO.	S-970586
Limestone, C-33 #57-67 washed, Martin-Marietta, Greenwood, MO.	S-970599
Limestone MHTD Grade E washed, Martin Marietta, Greenwood, MO.	S-970600

Granite, Martin-Marietta, Rock Springs, WI.	S-970621
Quartzite #67, L.G. Everist, Dell Rapids, SD.	S-970724
Quartzite #57, L.G. Everist, Dell Rapids, SD.	S-970725

Sources for Concrete Aggregates

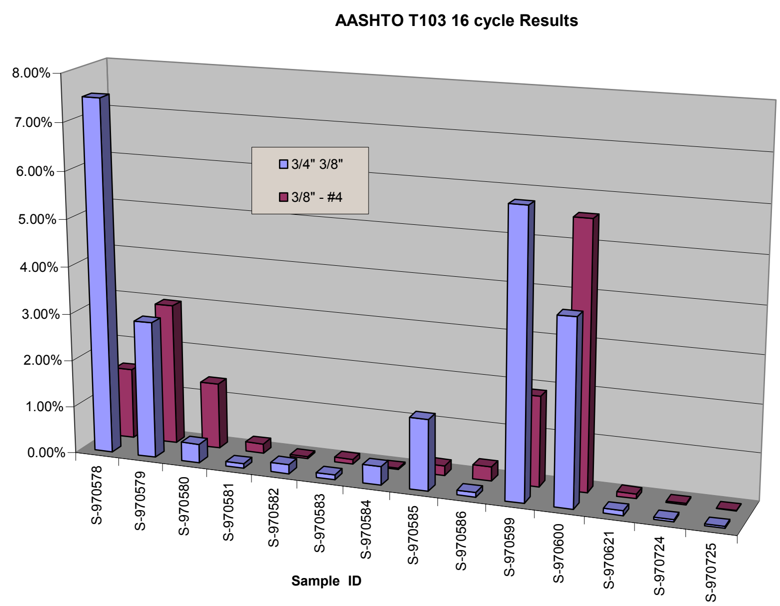


Aggregate Tests:

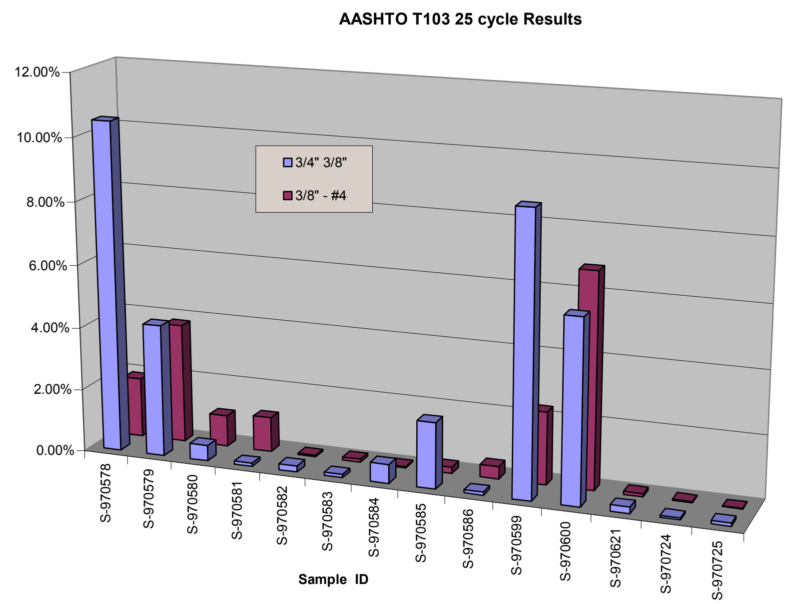
To evaluate the quality of a variety of aggregates, the City through a contract with Terracon, and the Concrete Promotional Group through an arrangement with Ash Grove Laboratories have conducted numerous aggregate tests. These tests are to determine whether aggregates from other areas exhibited significantly different durability characteristics than those from the KC metro area. Overland Park staff additionally conducted a simplified 50-cycle freeze-thaw test. <u>To identify the samples shown in the test results below, refer to Table 2</u>. The tests included:

AASHTO T103 Soundness by Freeze and Thaw

This test simulates the effects of freezing and thawing on the aggregates by saturating the aggregate with plain water, and while submerged in water alternately freezing and thawing the rock. At the conclusion of 16, 25 and 50 complete freeze-thaw cycles, the rock is analyzed for loss. At the beginning of the test, the aggregate is separated into specific size fractions through the use of laboratory sieves and then weighed. When analyzed for loss, each size fraction is re-sieved on a slightly smaller sieve and re-weighed. In effect, the test considers a slight reduction in the size of the aggregate particles to represent no loss. Figures 2 and 3 show the results of 16 and 25 cycles. *The lower values are better in these tests.*



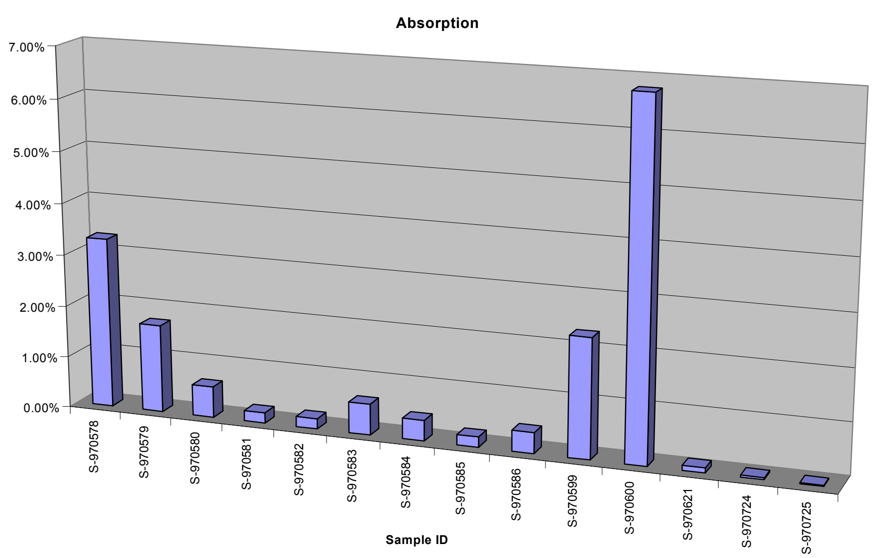
- **Figure 2 - 16 Cycle Freeze/Thaw**



• **Figure 3 - 25 Cycle Freeze/Thaw**

ASTM C127 – Specific Gravity and Absorption

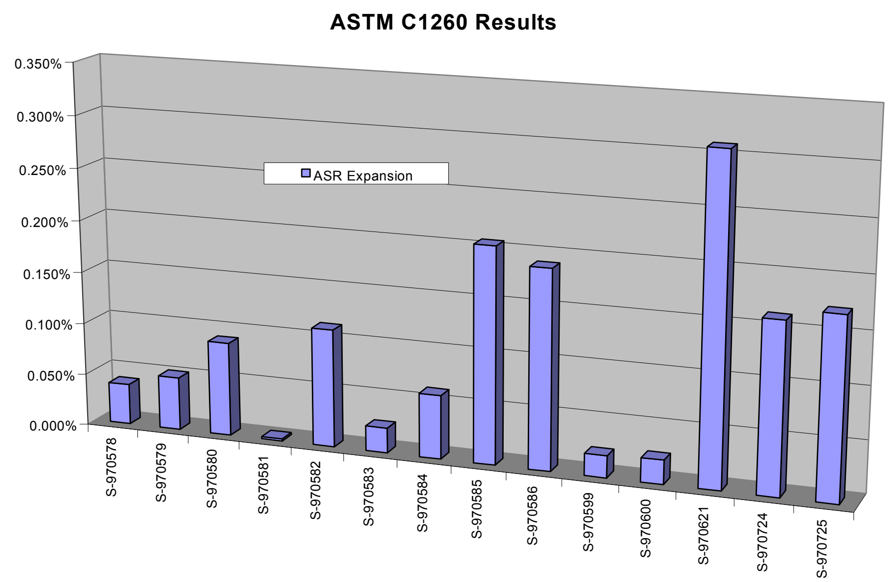
This test determines several of the physical characteristics of the aggregate. Absorption in particular can be an indicator for durability. Because the mechanism for freeze-thaw damage depends upon water entering the pore spaces in an aggregate and then freezing, those aggregates with very low absorption are less susceptible to damage. *Lower values are better in this test.*



• **Figure 4 – ASTM C127 Absorption**

ASTM C1260 – Potential for Alkali-Silica Reaction

This test determines whether an aggregate has the potential to react negatively with cement to produce unwanted expansions in the resultant concrete. These expansions can damage concrete, and may develop years or decades after the concrete is produced. Several inexpensive concrete additives exist which eliminate the problem. Ash Grove manufactures cement that also eliminates the problem. Several of the local sands exhibit this reaction. Limestone has properties with counteract the sand reactivity. If the City elects to use non-limestone coarse aggregates, the alkali-silica reactivity will need to be measured for both coarse and fine aggregates and steps taken to solve the problem. *Lower values are better for this test*.



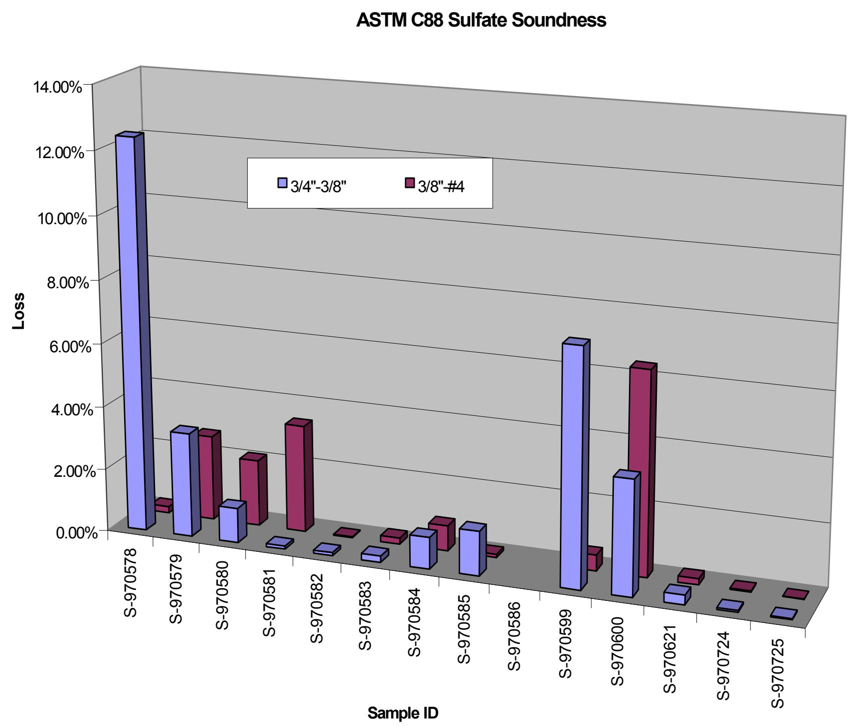
• **Figure 5 – ASTM C1260 Alkali Silica Reactivity**

ASTM C295 – Petrographic C294 Identification and Mohs Hardness

This procedure identifies the natural materials of which aggregates are composed. The results of this analysis help to determine the suitability of aggregates for use in concrete, and identify materials that may cause unwanted chemical reactions if left untreated. A trained geologist performs identification, and the testing is both time-consuming and expensive.

ASTM C88 – Sulfate Soundness ($MgSO_4$)

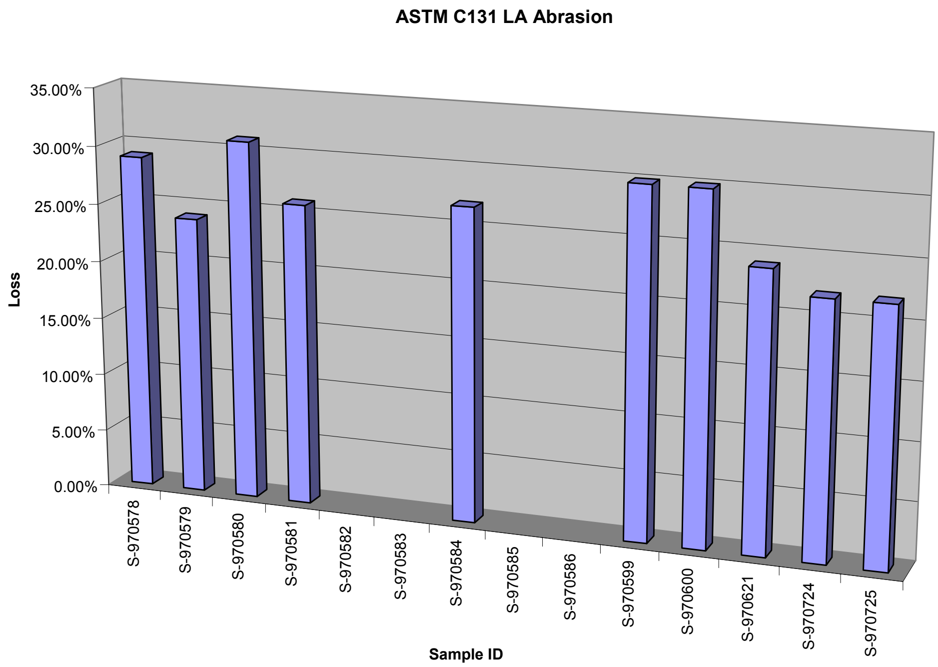
This test estimates the soundness of aggregates when subjected to weathering by repeated immersion in saturated solutions of magnesium sulfate followed by oven drying. It is not considered terribly accurate, and is used as an indicator test to be considered in conjunction with other testing. *Lower values are better.*



• **Figure 6 ASTM C88 Sulfate Soundess**

ASTM C131 – L.A. Abrasion

This test is an indicator of the resistance of an aggregate to abrasion and impact. It would distinguish the better stone from several aggregates with similar geologic characteristics. It is not necessarily meaningful to compare the results between aggregates that have dissimilar mineral compositions, limestone to granite, as an example. *Lower values are better, although comparisons should be made between similar geologic specimens.*



- **Figure 7 ASTM C131 L.A. Abrasion**

The results of the tests conducted by staff paralleled the preliminary results from Ash Grove. The photographs below show the results of fifty freeze thaw cycles on several of the rock specimens.

Before and after – Hunt Midwest C33 Limestone

Before and after – Shawnee Rock-KDOT Class 1 Limestone

Before and after – Iron Mountain Trap Rock

Empirical Data:

In conjunction with the testing, staff analyzed the curb condition for those curbs constructed after the change in concrete specification to the durable aggregate. Attached are maps that shows streets which exhibited signs of durability related distresses in the1996 and 1997 PAVER street inspection programs. One map shows streets where at least 5% of the curb sections have D-Cracking. The second map shows streets where at least 20% of the curb sections have D-Cracking. Both maps differentiate those streets which are less than 15 years old, and which were constructed using the KDOT durable aggregate. Distress at a 5% level is worth noting, but would not require further action. At the 20% level we would anticipate adding those streets to a curb replacement program in the near future, and would perform further inspections to establish priorities and to verify their condition.

During the summer of 1997, a team of PAVER inspectors was sent to the Kansas City, Missouri “Downtown Loop.” All of the concrete used in this section of Kansas City used trap rock as a coarse concrete aggregate. The PAVER inspectors visually inspected every curb and sidewalk in this entire area and were unable to find any D-cracking. Some of the pavements were date stamped as early as 1971; many were not date-stamped at all. Kansas City Public Works staff believed that trap-rock had been used in that part of KC since the late 1920s due to concern over the heavy application of de-icing salt during the winter.

Life-cycle cost analysis:

For purposes of analysis, staff analyzed the cost impact of the proposed concrete specification on curb construction. Of all of the components of infrastructure, concrete curb has one of the lowest labor costs -- roughly 10 percent of the material cost. At the opposite end of the spectrum, labor accounts for approximately 80 percent of the cost of bridge concrete. If the material costs were to double, the net increase would only be 20 percent. Since an increase in material cost would be a higher percentage of the total cost for items with lower labor costs, we felt that if changing the curb specification was justified in terms of life cycle cost, other public infrastructure components would realize greater savings and more justification.

The life cycle cost analyses used several parameters worth discussing. All costs incurred during the life of the curb were converted into a present value using standard financial formulas and an interest rate. For this analysis, the rate was the difference between the value of money and the rate of inflation. Since the City relies upon pay-as-you go funding and general obligation bond issues, the value of money was set at an average between the interest rates we could realize on our investments, and the interest we pay for our bond issues. The rate of inflation was taken from the Producer price index for construction materials over the last decade (just under 3%). Note that while inflation and return on investments have fluctuated over a wide range historically, the difference between them is less variable. The result of the foregoing analysis and a discussion with the Finance and Administration department was to set the interest rate for calculations between 3 percent and 5 percent. After setting other parameters, analysis showed that the new concrete would have lower life-cycle costs unless the interest rate exceeded 7% (assuming the new concrete would last 35 years) or 9% (assuming it would last 50 years).

For purposes of the analysis, costs were established conservatively for the new concrete aggregates. The percentage of rock used in the resulting concrete mix can vary from 35% to 50%; the analysis assumed 45%. It was assumed that the non-local aggregates would cost $20/ton to transport, a cost that would decrease with the establishment of efficient rail and or barge depots. For this analysis, new curb was estimated to cost $7.00 per foot using our current concrete specification and $1.75 more per foot for the proposed concrete or $8.75 per foot. Curb replacement costs were estimated at $16.20 per foot using our current specification, and the same $1.75 additional for the proposed specification for a total of $17.95 per foot. The following table calculated present value of future expenditures using an interest rate of 4%. Note that developers usually pay the initial cost of curb construction. The only curb installed by the City would be along thoroughfares.

- **Table 3 Life-cycle Costs for Curb**

Life cycle Year	Present Value Existing Std. Curb	Present Value Improved Std. Curb - 35 year life	Present Value Improved Std. Curb - 50 year life
0	$7.00	$8.75	$8.75
25	$6.08		
35		$4.55	
50	$2.28		$2.53
70		$1.15	
75	$0.86		
100	$0.32		$0.36
105		$0.29	
Total Life-Cycle Cost	**$16.53**	**$14.74**	**$11.63**
	Savings per foot with improved standard	$1.79	$4.90

Looking at all curbs in the City; there are several facts that have long-term budget implications. PAVER data shows that there are 8,247,360 feet of curb in Overland Park. A simplistic determination of annual replacement cost could be made by dividing the product of the total length of curb and the replacement cost per foot by the estimated life of the curb. Using a replacement cost of $16.20 or $17.95 as before, that table is as follows:

- **Table 4 Annual Replacement Costs**

Replacement Cost value of all curb divided by -- >>	25 years - also using lower replacement cost	35 years	50 years
	$5,344,289	$4,229,717	$2,960,802

Because much of Overland Park is relatively new, these annual costs exceed our actual expenditures. As the City ages our curb replacement costs will increase to these levels if the life expectancy of our curbs are correct.

Another cost determination can be accomplished by annualizing the life cycle cost of all curbs in Overland Park by multiplying the length of curb by the life cycle costs calculated in Table 3. These values include the original construction cost that makes the resulting figures higher than pure annualized maintenance costs. The rate used to determine the annual cost was again 4%.

- **Table 5 Annualized Life-cycle Costs**

Present Value - all curb in OP	$136,347,769	$121,596,335	$95,926,711
Annualized Cost	($5,544,137)	($4,944,318)	($3,900,547)
Annual Savings vs. Existing concrete		**$599,819**	**$1,643,590**

For 1998, Overland Park will spend approximately $1,000,000 on curb replacement. As the City ages, that number will increase.

Other Issues

Overland Park's initial objective was to determine the feasibility of replacing our local sources of limestone aggregates with a more durable aggregate. After a number of meetings with concrete producers, aggregate producers, and the CPG, additional issues were raised that we acknowledge are important to the success of our endeavor to produce durable concrete.

1. Easy identification of durable aggregates. A long standing concern is that the durable limestone aggregates are not field identifiable, and cannot be identified in a laboratory from cores taken from finished concrete structures. The durable and the non-durable aggregates cannot easily be distinguished from each other by visual observation, and in fact considerable laboratory testing is required to identify the durable limestone aggregate. That identification is performed by KDOT, and is a procedure that identifies rock ledges suitable for use as concrete aggregates. Once the rock has been removed from the ledge, the City has no controls which assure that we are getting that rock in our concrete other than certifications from the concrete producer who in turn relies upon his aggregate supplier's certifications. If we elect to use non-limestone aggregates, they are readily identifiable in the field by washing a small sample of concrete prior to its placement. It can also be readily identified in concrete cores cut from the finished product. Most of the non-local aggregates under consideration have a distinctive color that makes them easy to identify. In some cases, the aggregate color may slightly change the color of the finished concrete, further distinguishing the durable aggregates.

   Staff feels that the approved concrete suppliers who provide the City with concrete make and have made a conscientious effort to supply the correct aggregates in any concrete supplied to the City since the change in our ordinance requiring a specific aggregate. Despite that fact, it is likely that they have batched concrete using the wrong aggregate and delivered it to us. Our ability to easily identify the concrete is an additional safeguard that will help to ensure that the concrete we use is durable. The easily identifiable aggregates will benefit the aggregate suppliers who stockpile the rock and who have operators that are asked to supply a specific aggregate. It will benefit those that transport the rock to the concrete producers and are asked to deposit the rock in one of many stockpiles. It will benefit the concrete producers who will stockpile aggregates to satisfy demand and who have plant operators that select various concrete components from a variety of sources. Finally, it will benefit the City who will be able to easily determine that we have received the product that was specified.

2. Batching, transportation, placement, curing. A long-standing concern among concrete producers is that the City lacks controls and specifications necessary to ensure compliance with high standards of practice for all of the areas where concrete is handled. If the City adopts a new higher standard for concrete, it is important to also tighten other quality assurance controls.

   We lack a minimum standard for concrete batch plants. Some of the smaller plants have equipment that makes batching concrete from a wide selection of materials difficult. These smaller plants may have too few hoppers to store more than three or four aggregates and may rely upon obsolete weighing and batching equipment. The City could set minimum standards for concrete producers, and only add plants that met those minimum standards to the approved supplier list. The Concrete Promotional Group has offered assistance in setting those minimum standards.

   Transportation from the plant to the job site is another phase of the process with few quality assurance controls. It is important that the concrete be thoroughly agitated in the mixer and placed within a specific time after batching. Concrete mixers have revolution counters that are seldom reset, and some, but not all of the batch plants have modern ticket printers that include the time of batching. With minimum standards for concrete producers, we could require the necessary information on concrete tickets, and could require that concrete trucks have operational (and reset) revolution counters.

   Once concrete is delivered to the job site, water is often added, and it is difficult for a single City inspector to control the cadre of finishers who may overfinish the surface. State Highway departments often employed individual inspectors at each phase of the process, and today utilize more inspectors for concrete production and placement than most cities. The City could require private lab inspectors to assist with concrete pours, especially where we would expect considerable hand finishing.

3. Interstate Highway vs. city street. Many in the industry feel that the KDOT durable rock determination has solved the durability problem for state highways. It may have. KDOT durable rock is much more resistant to freezing and thawing than the commercial rock generally used in this area. However, Interstate highways are considerably different than city streets in terms of drainage. Highways are normally elevated so that they are the highest feature in an immediate area. Even in cut sections, ditches are cut on either side of the roadway to promote drainage away from the roadway. Interstates are often constructed over drainable bases that remove moisture from the underside of the pavement. In contrast, city streets are often used as a stormwater conveyance, and generally are the lowest feature in an area. Highways are uncurbed for safety, and to promote

good drainage. Curbs on city streets carry water by design, and in winter months tend to trap snow and ice which keeps curb concrete continuously saturated.

4. Competition and availability of aggregates. Armed with test results, maps of rail lines and river barge routes, it would be tempting to select the very best aggregate from the list of those tested, and then write a specification around that specific rock. The CPG and staff agree that by developing a specification which allows a wide variety of aggregate types and sources, that the competition within the marketplace will produce the most economical concrete. Staff would prefer establishing minimum standards that solve the durability problems and provide quality concrete with as wide a variety of rock sources as possible.

5. Developers construct much of the public infrastructure in Overland Park. If the City adopts a new concrete ordinance requiring a more expensive aggregate, the cost of developing subdivisions in Overland Park will increase. Once we have an opportunity to better determine the actual cost increase, the City may wish to consider delaying an increase in excise tax or some other similar measure in recognition of those additional costs. The long-term savings in maintenance costs would pay for the higher initial costs.

6. Durable concrete may have lower life-cycle costs as a paving material. City thoroughfare streets are overlayed on a ten-year or shorter cycle. Asphalt as a paving material has difficulty in resisting the traffic loadings encountered on streets such as Metcalf Avenue. Concrete is a rigid pavement, and can be designed to carry much greater loads. If we could obtain concrete capable of surviving 35 or more winters, we could design a thoroughfare that would require minimal maintenance in that period. In the past, staff has resisted using concrete as a paving material due to concerns regarding its durability, and its higher replacement costs. Staff would recommend including concrete alternates for new thoroughfare projects, and for thoroughfare rehabilitation projects, and would recommend selecting the alternate with the lowest life-cycle costs.

The Interim Specification

The following is the specification that will be used for the Mission Road joint project with Leawood. It modifies a standard KDOT concrete aggregate specification, and thus includes all other provisions for quality that are a part of the standard KDOT specification. Limestone is excluded from this specification entirely.

Subsection 1102
Aggregates for Concrete

Delete 1102.02(a)(1.1) *Coarse Aggregate for Concrete other than Pavement*, and 1102.02(a)(1.2) *Coarse Aggregate for Concrete Pavement* and insert:

1102(a)(1.1) *Coarse Aggregate for Concrete other than Pavement,* crushed stone shall be entirely granite, quartzite, sandstone, or trap rock

Soundness, minimum .... 0.98[1]

Expansion (ASTM C 1260), maximum .... 0.1%[2]

1102(a)(1.2) *Coarse Aggregate for Concrete Pavement,* crushed stone shall be entirely granite, quartzite, sandstone, or trap rock

Soundness, minimum .... 0.98[1]

Expansion (ASTM C 1260), maximum .... 0.1%[2]

[1] Soundness shall be determined through the use of the AASHTO T103 freeze-thaw test, Method A, 25 cycles.

[2]Expansion limit will be waived if the concrete mixture contains one of the following in sufficient amounts to reduce the expansion to less than 0.1%: calcined clay, class F fly ash, silica fume, or ground granulated blast-furnace slag. Note that expansion shall be determined on the combination of coarse and fine aggregates proportioned as proposed for the mix design submitted for review.

Summary

Changing the specification for concrete aggregate is cost justified for all concrete used to construct any public infrastructure. Staff recommends adoption of an interim specification for adoption in the spring of 1998 that would be replaced at the conclusion of the testing and discussions of other issues with the Concrete Promotional Group. If the new specification is as durable as we believe it will be, the City should consider using concrete as a paving material for high-volume thoroughfares such as Metcalf provided that life-cycle cost analysis show that it would be less expensive over the life of the pavement. The Concrete Promotional Group has been extremely helpful in working with the City to analyze and solve this problem. They have spent a considerable sum of money in testing various aggregates. The City should continue to partner with them as we develop the final specifications and guidelines.

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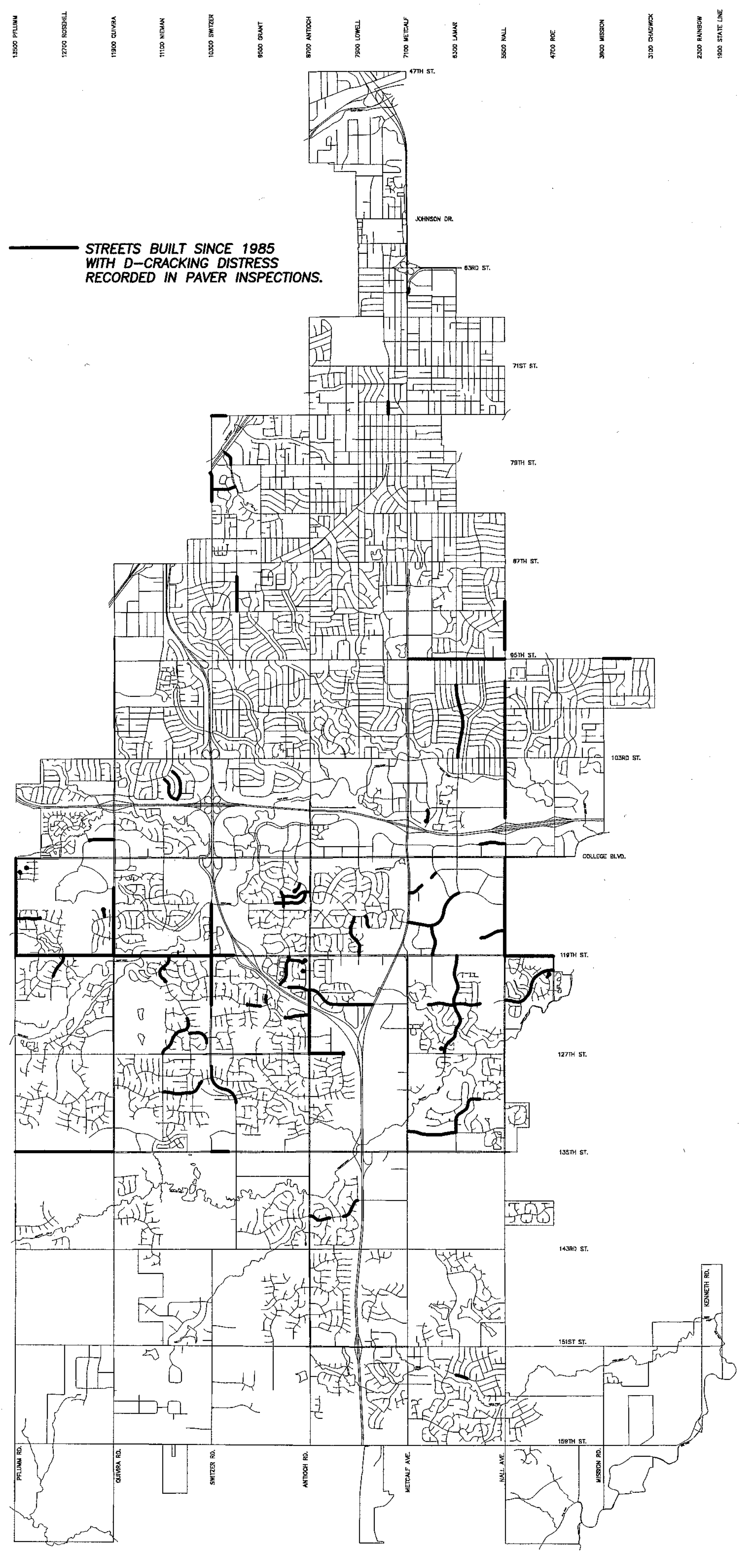
STREETS BUILT SINCE 1985
WITH D-CRACKING DISTRESS
RECORDED IN PAVER INSPECTIONS.
13500 PFLUMM
12700 ROSEHILL
11900 QUIVIRA
11100 NIEMAN
10300 SWITZER
9500 GRANT
8700 ANTIOCH
7900 LOWELL
7100 METCALF
6300 LAMAR
5500 NALL
4700 ROE
3900 MISSION
3100 CHADWICK
2300 RAINBOW
1900 STATE LINE
47TH ST.
JOHNSON DR.
63RD ST.
71ST ST.
79TH ST.
87TH ST.
95TH ST.
103RD ST.
COLLEGE BLVD.
119TH ST.
127TH ST.
135TH ST.
143RD ST.
151ST ST.
159TH ST.
KENNETH RD.
PFLUMM RD.
QUIVIRA RD.
SWITZER RD.
ANTIOCH RD.
METCALF AVE.
NALL AVE.
MISSION RD.