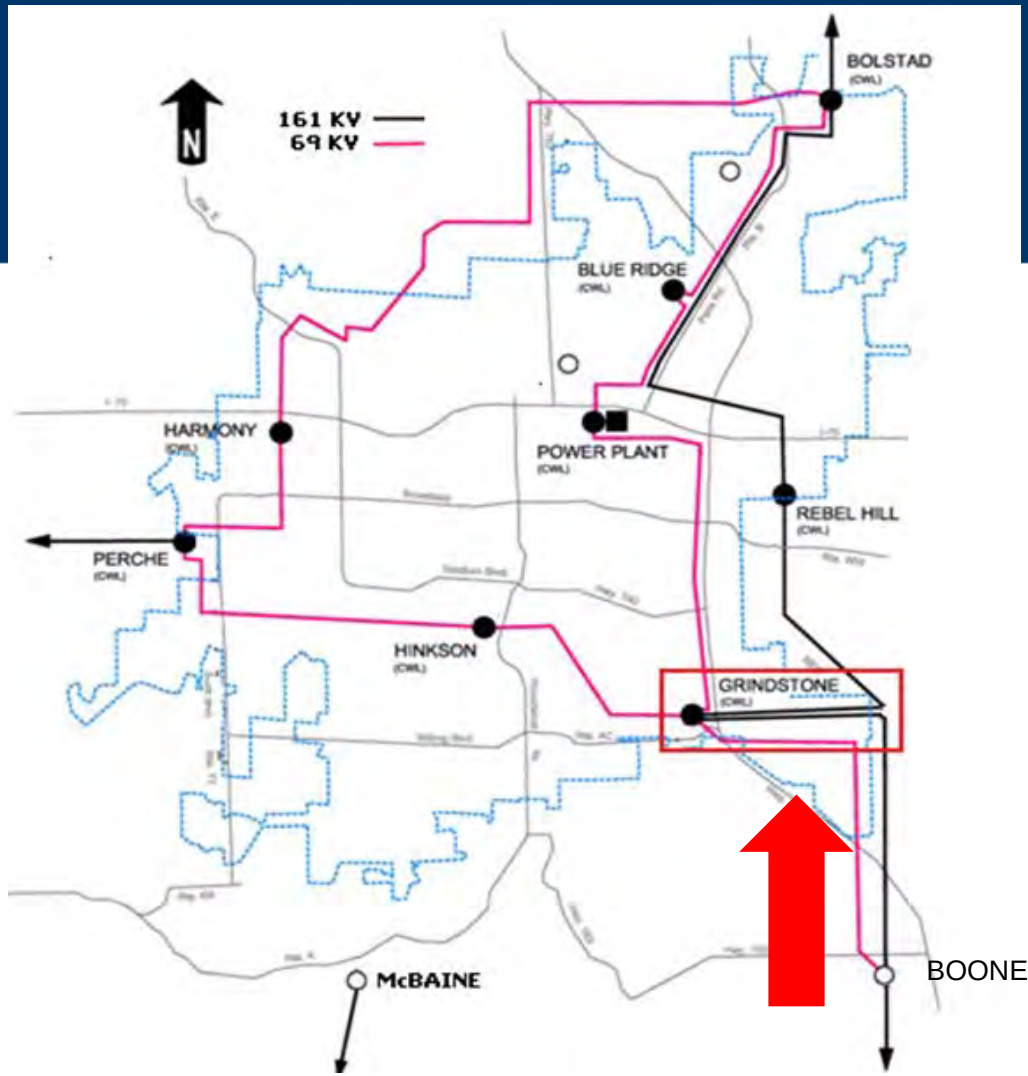
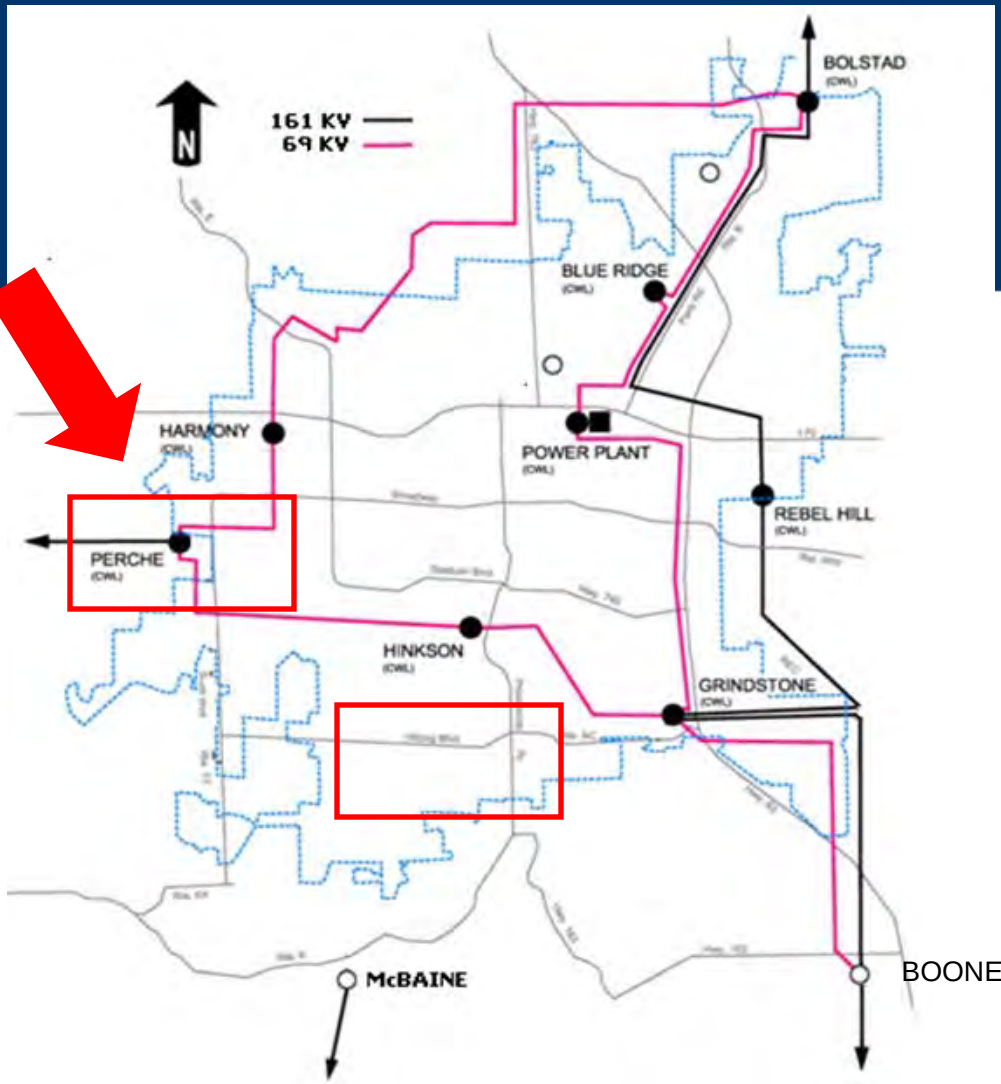
Transmission Line Project



System Improvements:

- 161KV Transmission Line Grindstone to Boone 161KV
- Eliminates Columbia's impact on neighboring utilities
- Completed 2007

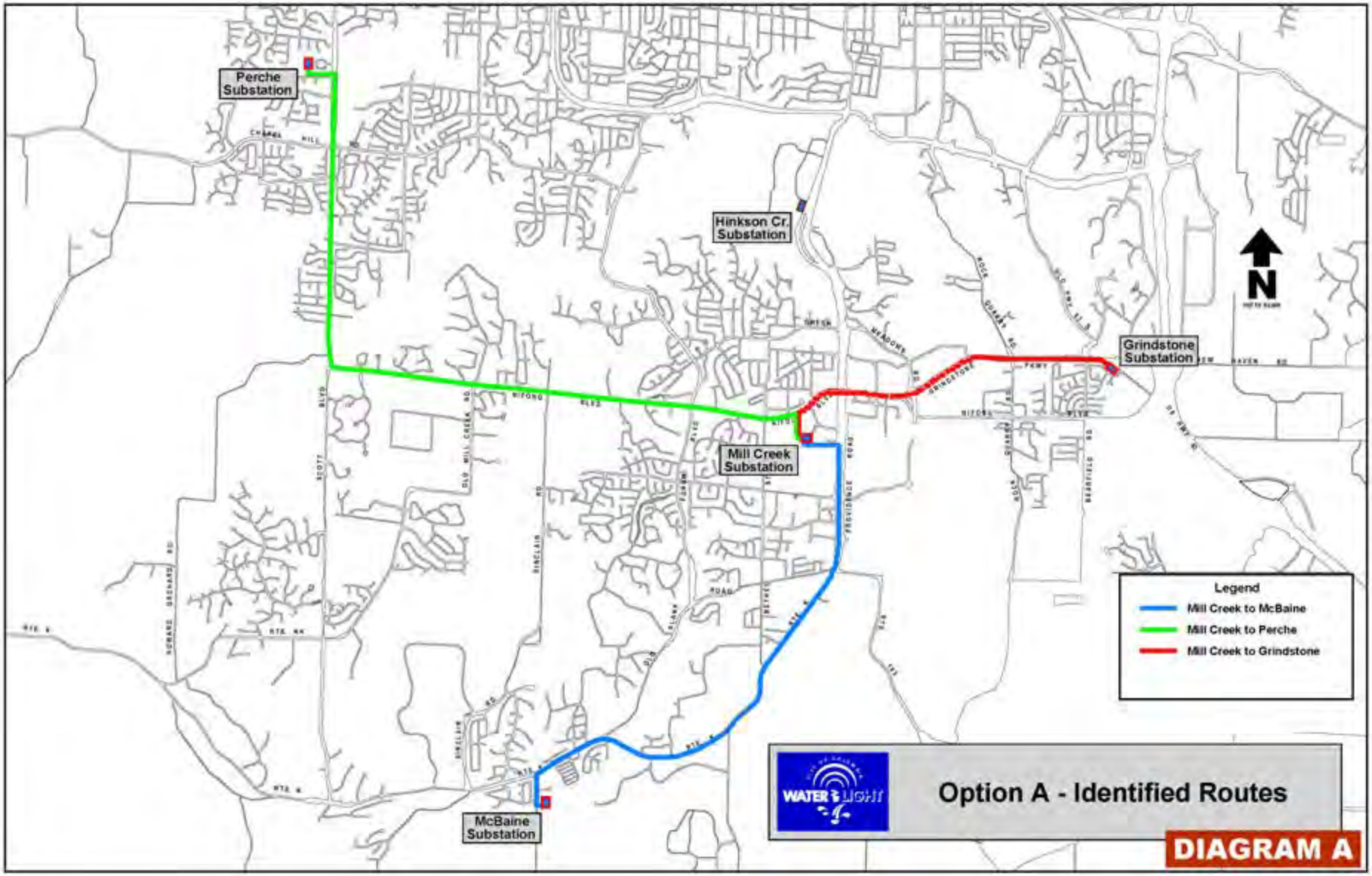


System Improvements:

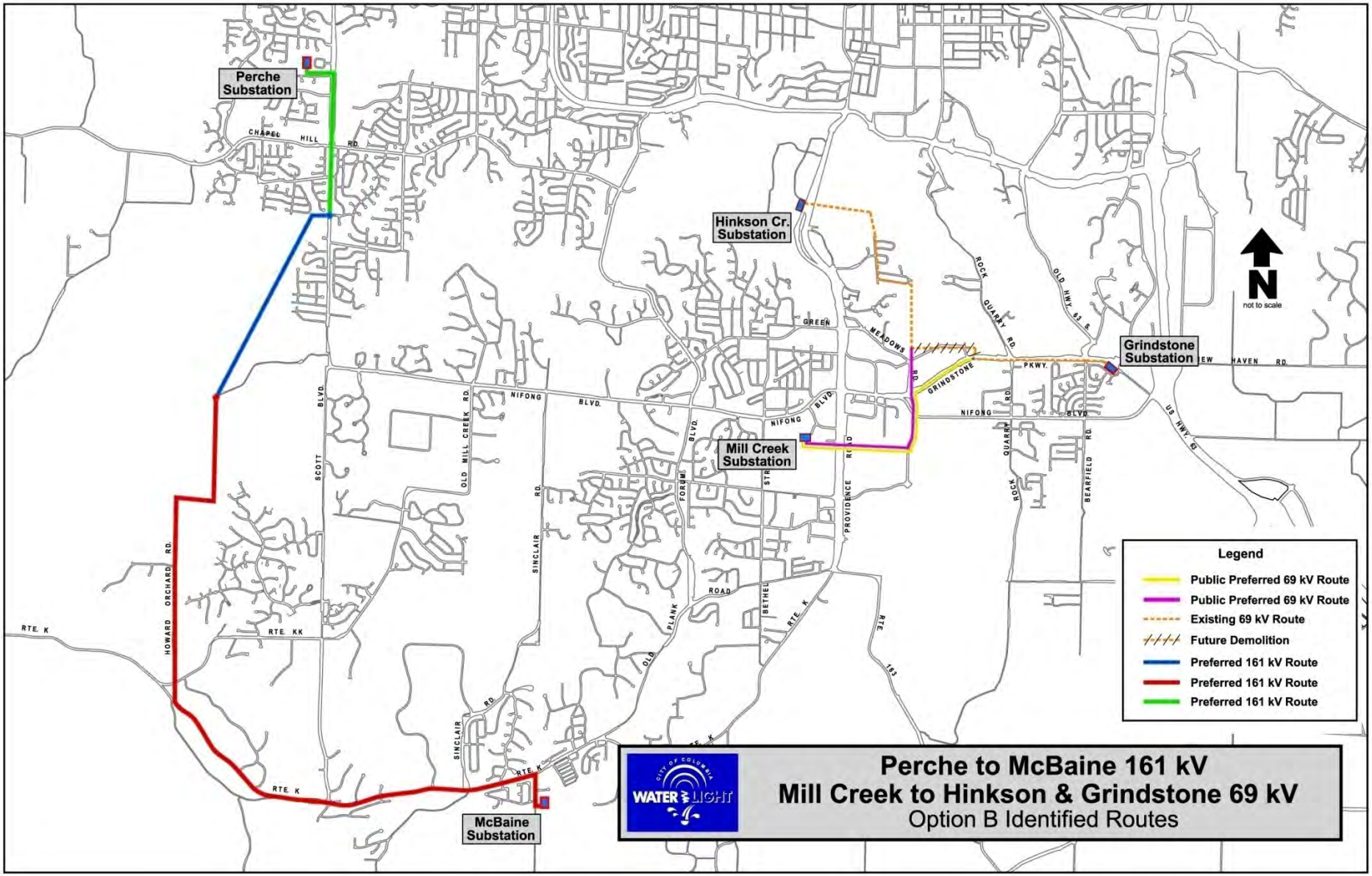
- 161KV Transmission Line into Perche Creek
- Substation in Southern part of Electric Service Territory

BOONE SUBSTATION

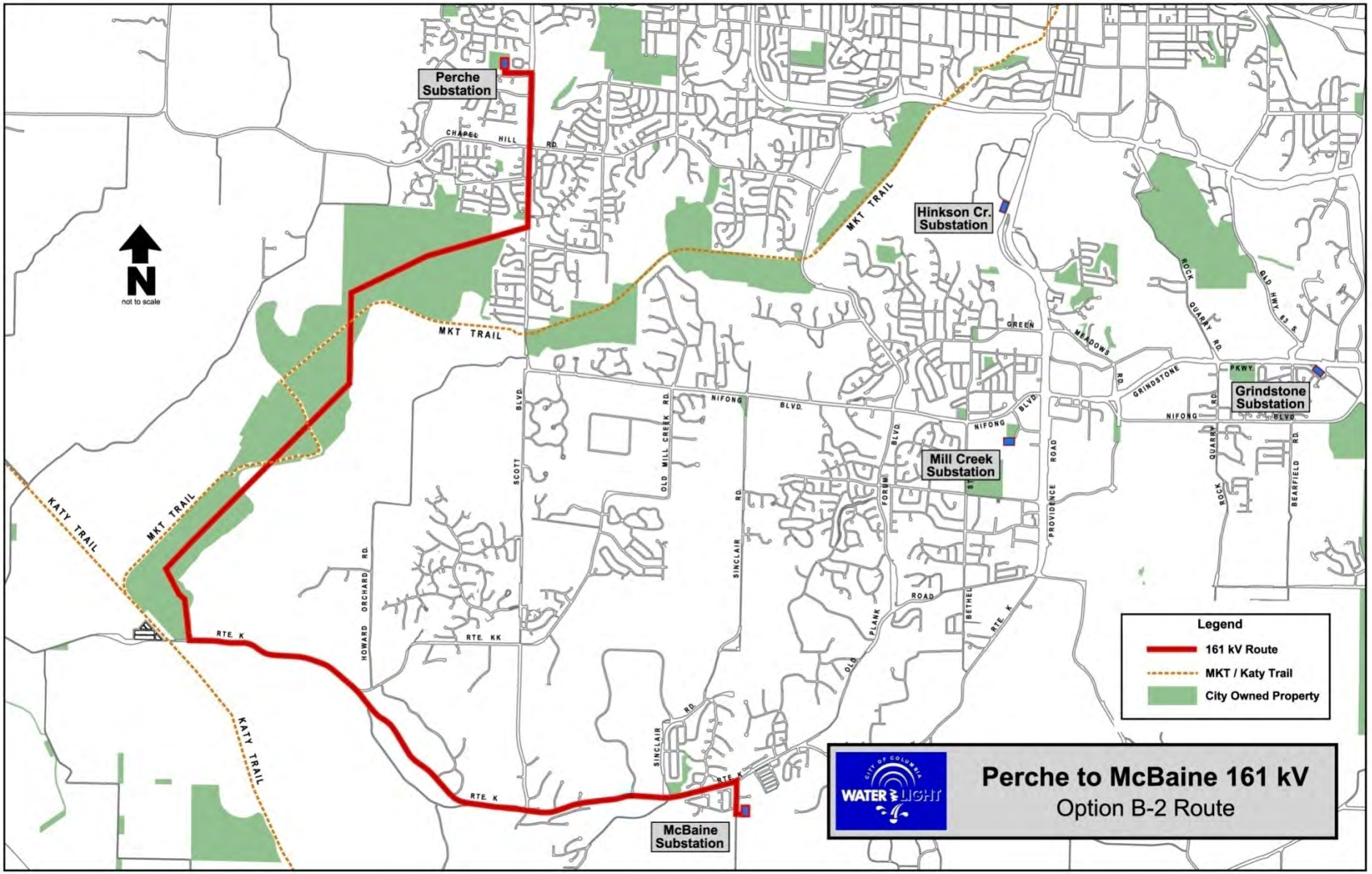
Option A


Perche Substation
Hinkson Cr. Substation
Grindstone Substation
Mill Creek Substation
McBaine Substation
N
Legend
Mill Creek to McBaine
Mill Creek to Perche
Mill Creek to Grindstone
WATER LIGHT
Option A - Identified Routes
DIAGRAM A

Option B


Perche Substation
Hinkson Cr. Substation
Mill Creek Substation
Grindstone Substation
McBaine Substation
CHAPEL HILL RD.
NIFONG BLVD.
GREEN MEADOWS
GRINDSTONE PKWY.
OLD HWY. 63 S.
ROCK QUARRY RD.
NEW HAVEN RD.
US HWY. 63
SCOTT BLVD.
OLD MILL CREEK RD.
SINCLAIR RD.
FORUM BLVD.
STRAWN RD.
PROVIDENCE RD.
BEARFIELD RD.
HOWARD ORCHARD RD.
RTE. K
RTE. KK
OLD PLANK ROAD
BETHEL RTE. K
RTE. 163
not to scale
Legend
Public Preferred 69 kV Route
Public Preferred 69 kV Route
Existing 69 kV Route
Future Demolition
Preferred 161 kV Route
Preferred 161 kV Route
Preferred 161 kV Route
CITY OF COLUMBIA WATER & LIGHT
Perche to McBaine 161 kV
Mill Creek to Hinkson & Grindstone 69 kV
Option B Identified Routes

Option B-2


Perche Substation
Hinkson Cr. Substation
Mill Creek Substation
Grindstone Substation
McBaine Substation
MKT TRAIL
KATY TRAIL
CHAPEL HILL RD.
NIFONG BLVD.
SCOTT BLVD.
OLD MILL CREEK RD.
SINCLAIR RD.
FORUM BLVD.
PROVIDENCE ROAD
GREEN MEADOWS RD.
GRINDSTONE PKWY.
ROCK QUARRY RD.
BEARFIELD RD.
BETHEL RD.
OLD PLANK ROAD
HOWARD ORCHARD RD.
RTE. K
RTE. KK
OLD HWY. 63 S.
not to scale
Legend
161 kV Route
MKT / Katy Trail
City Owned Property
CITY OF COLUMBIA WATER & LIGHT
Perche to McBaine 161 kV
Option B-2 Route

Estimated Costs of Options

	OPTION A	OPTION B	OPTION B-2
Est. years before more needed	20+	10 TO 20	10 TO 20
Miles of 161 kV lines	12.07	6.99	9.84
Miles of 69 kV lines	0	2.97	2.97
Total overhead construction	$13,135,117	$10,151,122	$12,229,788
Total underground construction	$91,898,566	$75,833,448	$97,532,778
Monthly Cost/Customer 20 years overhead	$1.18	$0.91	$1.10
Monthly Cost/Customer 20 years underground	$8.26	$6.82	$8.87

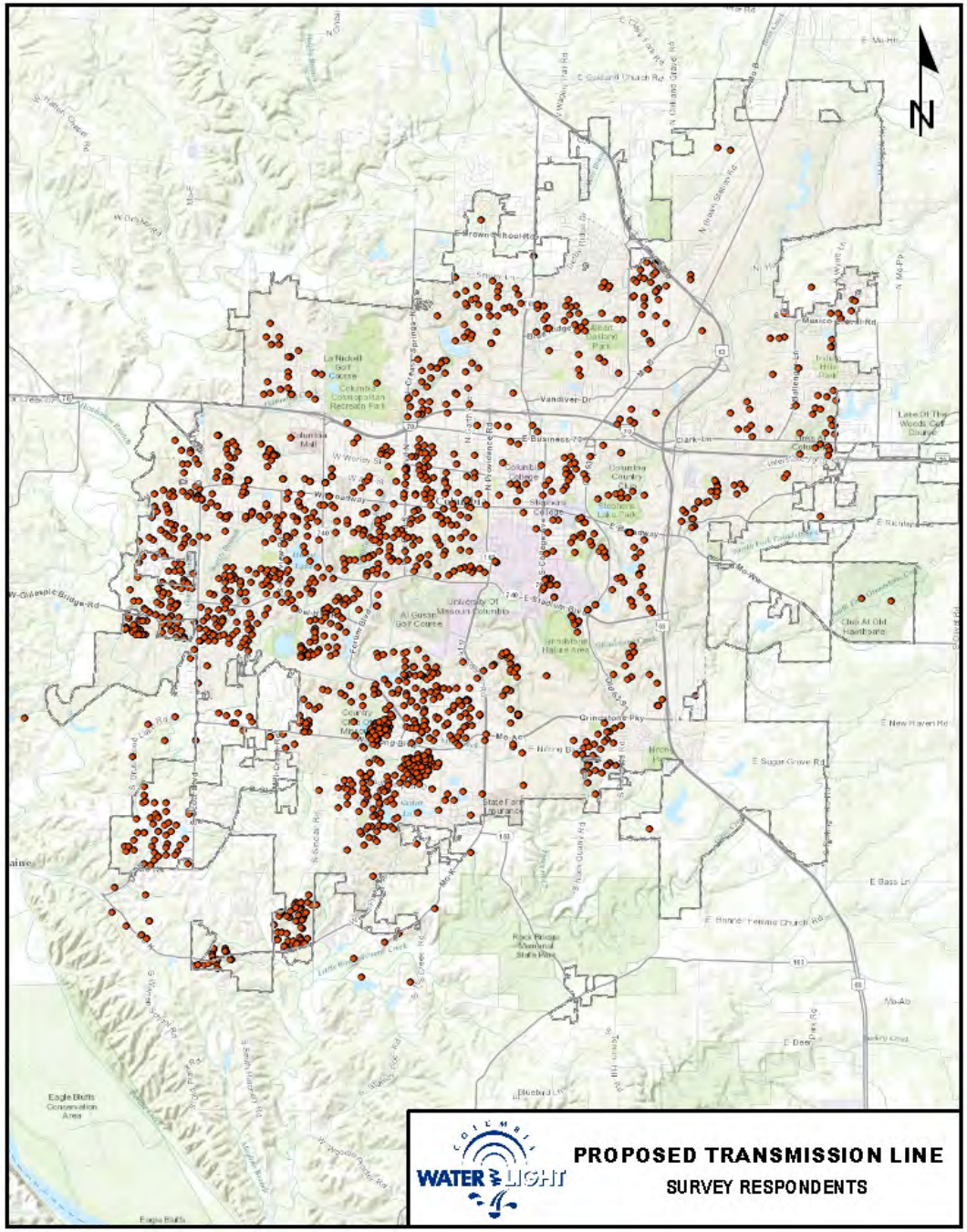
NOTES

-Easement costs are not included in estimates. Option A makes use of existing right-of-way and platted easements

-Unlike distribution lines, transmission lines are not commonly buried due to high cost & lower life expectancies

The Survey

- At the Open House held in November 2012 (the open house whose purpose was to determine the public's preferences regarding Option A, Option B, and Option B-2) the attendants were advised to fill out an online survey
- This survey was open to the public at large to complete online or on paper
- Sent a letter to every electric customer advising them of the available online survey
- Received over 1,500 responses


N
COLUMBIA WATER & LIGHT
PROPOSED TRANSMISSION LINE
SURVEY RESPONDENTS

Public's Rank of Importance

1) Reliable electric service	16.2%
2) Option provides longest-term solution	15.3%
3) Least cost to build/minimize rate impact	12.6%
4) Proximity to residential homes (this includes apartments)	12.5%
5) Environmental impact	11.8%
6) Negative aesthetic impacts	11.7%
7) Proximity to schools, day cares, churches, hospitals, nursing homes	11.3%
8) Proximity to commercial businesses	8.6%

The Matrix

- In addition to directly asking the public which option they would prefer to see implemented, Sega, Inc. worked to develop a criteria for ranking each route according the Public Rank of Importance.
- This ranking criteria was used to create a Matrix.
- This Matrix is a algorithm of the publically-ranked factors and incidences of occurrence applied to each option objectively.
- For consistency, the Matrix used to rank the options was the same matrix used to rank the individual routes of each option in previous studies.

The Matrix

Results of the Matrix Analyzing Community Impacts vs. Benefits

- Option A: -36,341
- Option B: -35,739
- Option B-2: -35,528

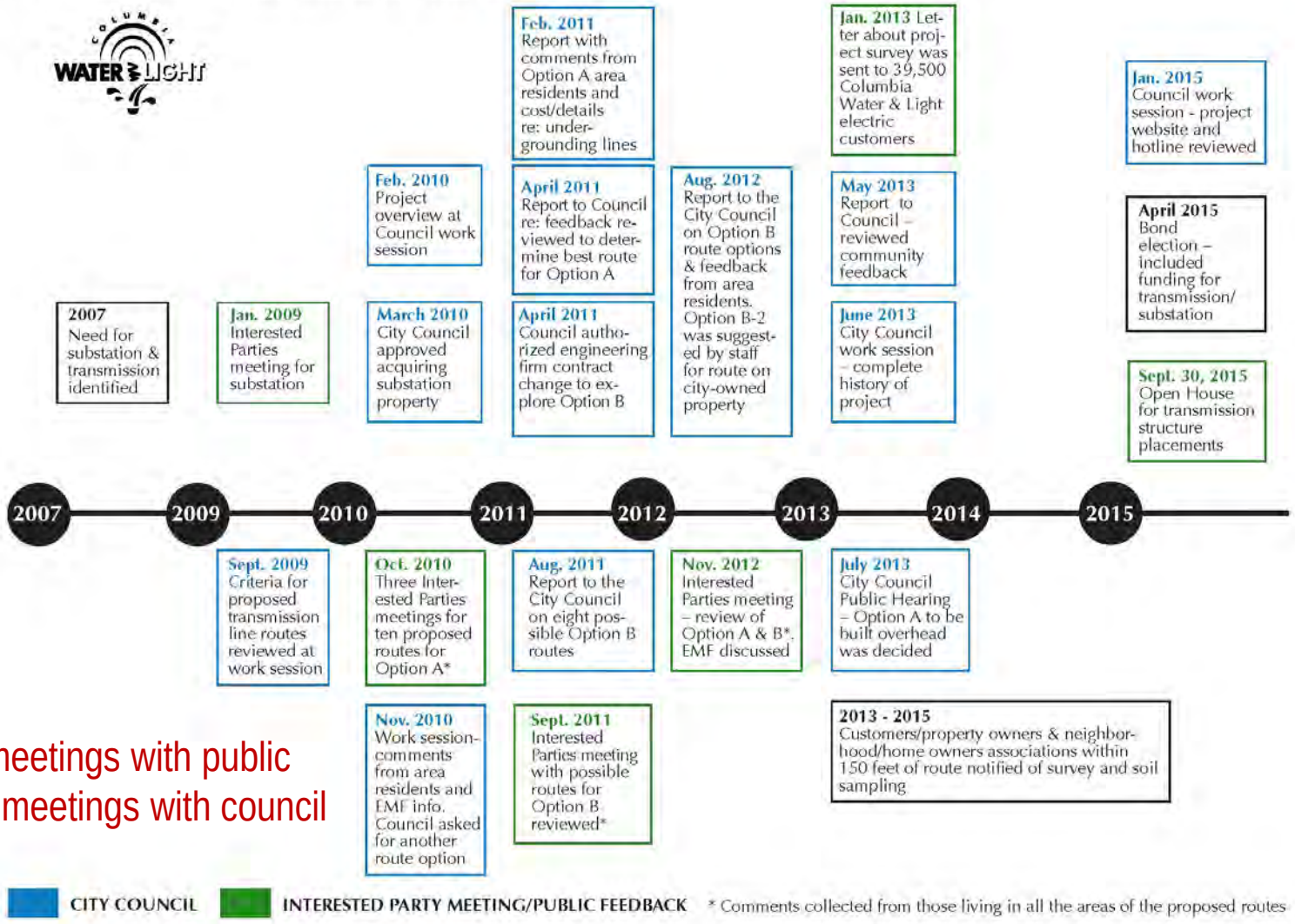
Staff Recommendation of Option A

- Solve the need for both the transmission and distribution capacity for the longest term with a single cost effective solution.
- Transfers load to the 161 kV system and preserves current 69 kV capacity
- 161 kV option more than double the power transmission capacity
- Does not require rebuild of existing 69kV system
- Provides connections between 3 different import substations which is a more reliable & longer term solution
- Water & Light Advisory Board endorsed Option A without undergrounding options

AT A GLANCE

Columbia Water & Light's Electric Transmission and Substation Project

HISTORICAL INFORMATION



6 meetings with public
12 meetings with council

Timing of Project

- Electric systems must have reserved capacity for high loads and/or problems with system
- Substation loading goal: 2 transformers at 50%, 3 transformers at 66.6%

Year	Grindstone (3*)	Hinkson (3*)	Perche (2*)
2007	41.5%	67.6%	61.8%
2010	44.7%	68.6%	64.4%
2015	48.6%	64.2%	72.0%

*number of transformers

Timing of Project

- Need for distribution capacity in 2018 due to critical levels at Grindstone, Hinkson & Perche substations
- Need for transmission capacity based on area aggregate load (Columbia, Fulton and UMC)
  - Modeling indicates the need for the transmission improvement when Columbia Load exceed 300 MW, currently forecasted 2017-19
- Benefit of solving both the transmission and distribution capacity for the longest term with a single cost effective solution

Funding of Project

- Combination of revenue and bond funds for project
- Transmission from Millcreek to McBaine substation not funded in next 5 years but will be built
- April 2015 election: bond project funds allocated

Transmission & Substation Project Total	$36,150,000
Millcreek 161/69 kV substation	$5,000,000
Millcreek, Grindstone & Perche interconnection	$18,000,000
Substation upgrades Grindstone & Perche	$1,000,000
Underground distribution lines in transmission corridor	$5,000,000
Substation feeder reconfiguration	$7,150,000

Funding of Project

- As of October 2015: $7.1 million of revenue and bond funds spent
  - Substation land: $1.5 million
  - 161 kV equipment: $2.3 million
  - Engineering: $3.3 million
- Impact of changing the route: $5.6 million lost & would need to be budgeted
- Option B cost would include more money budgeted for easements
- Changing to Option B:
  - Delay in-service date by 4 to 5 years
  - New modeling for when additional transmission would be needed since relying on 69kV system

Real Estate Impact*

Option A
Agricultural – 17,600
Commercial – 23,760
Residential – 36,160

Grindstone to McBaine
Agricultural - 9,500 ft
Commercial - 8,300 ft
Residential - 23,650 ft

*Values in Linear Feet
This includes property on both sides of the line

Option B
161kV Line:
Agricultural – 56,000
Commercial – 2,600
Residential – 24,000

69kV Line:
(modeled as extension from existing infrastructure path)
Agricultural – 2,200
Commercial – 10,500
Residential – 2,000

Electric & Magnetic Fields (EMF)

EMF Units

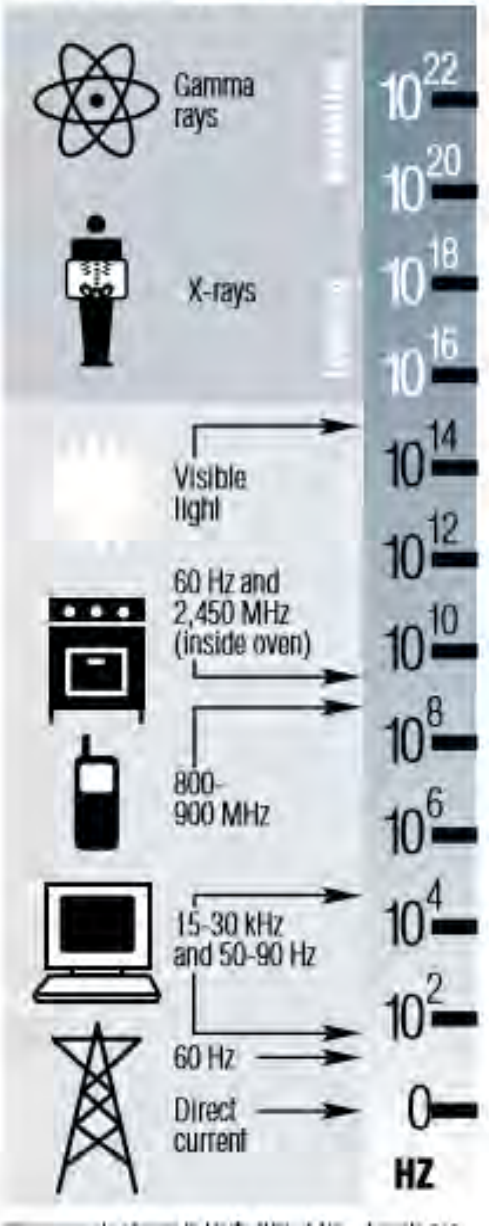
Electric Fields

Usually measured in volts per meter (V/m)
For large fields the units usually used are:
1 kilovolt per meter (kV/m) =
1,000 volts per meter

Magnetic Fields

Usually measured in milliGauss (mG)
Other units sometimes used:
1 microTesla = 10 milliGauss
1 Amp/meter = 0.1257 milliGauss

Electromagnetic Spectrum

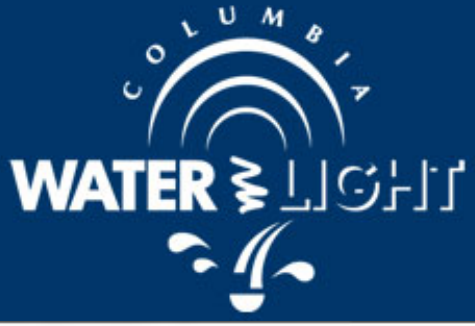


Magnetic Fields *(milligauss)*		
Product	**At The Head****	**4 inches From The Body***
Cellular Phone	1.2 to 2	N/A
Coffee Maker	N/A	2.3 to 3
Alarm Clock	N/A	5 to 15
Toaster	N/A	10 to 60
Iron	N/A	12 to 45
Vacuum Cleaner	N/A	230 to 1300
Hair Dryer	N/A	3 to 1400
Television	N/A	4.8 to 100

* Source: Gauger, Jr., Household Appliance Magnetic Field Survey. IEEE transactions on power apparatus and systems. PA-104
** Source: Medical College of Wisconsin

At a distance of 300 feet (91 meters), magnetic fields are similar to the typical 2 milligauss background levels found in most homes.

EMF Research



Power Lines, Electrical Devices and Extremely Low Frequency Radiation

How are people exposed to ELF radiation?

Generating, transmitting, distributing, and using electricity all expose people to ELF radiation. Some sources include power lines, household wiring, and anything using electricity. This can include anything from refrigerators and vacuum cleaners to television sets and computer monitors (when they are on). Even electric blankets expose people to ELF radiation.

How much electromagnetic radiation someone is exposed to depends on the strength of the field, the distance from the source of the field, and the length of time the person is exposed. The highest exposure occurs when the person is very close to a source putting out a strong field and stays there for a long period.

Does ELF radiation cause cancer?

In children

In the studies that have looked at a possible link between ELF radiation from magnetic fields in the home and **childhood leukemia**, the results have been mixed. Still, when the findings from these studies are combined, a small increase in risk is seen for children at the highest exposure levels compared to those with the lowest exposure levels.

Studies that looked at the effect of ELF electric fields on childhood leukemia did not find a link.

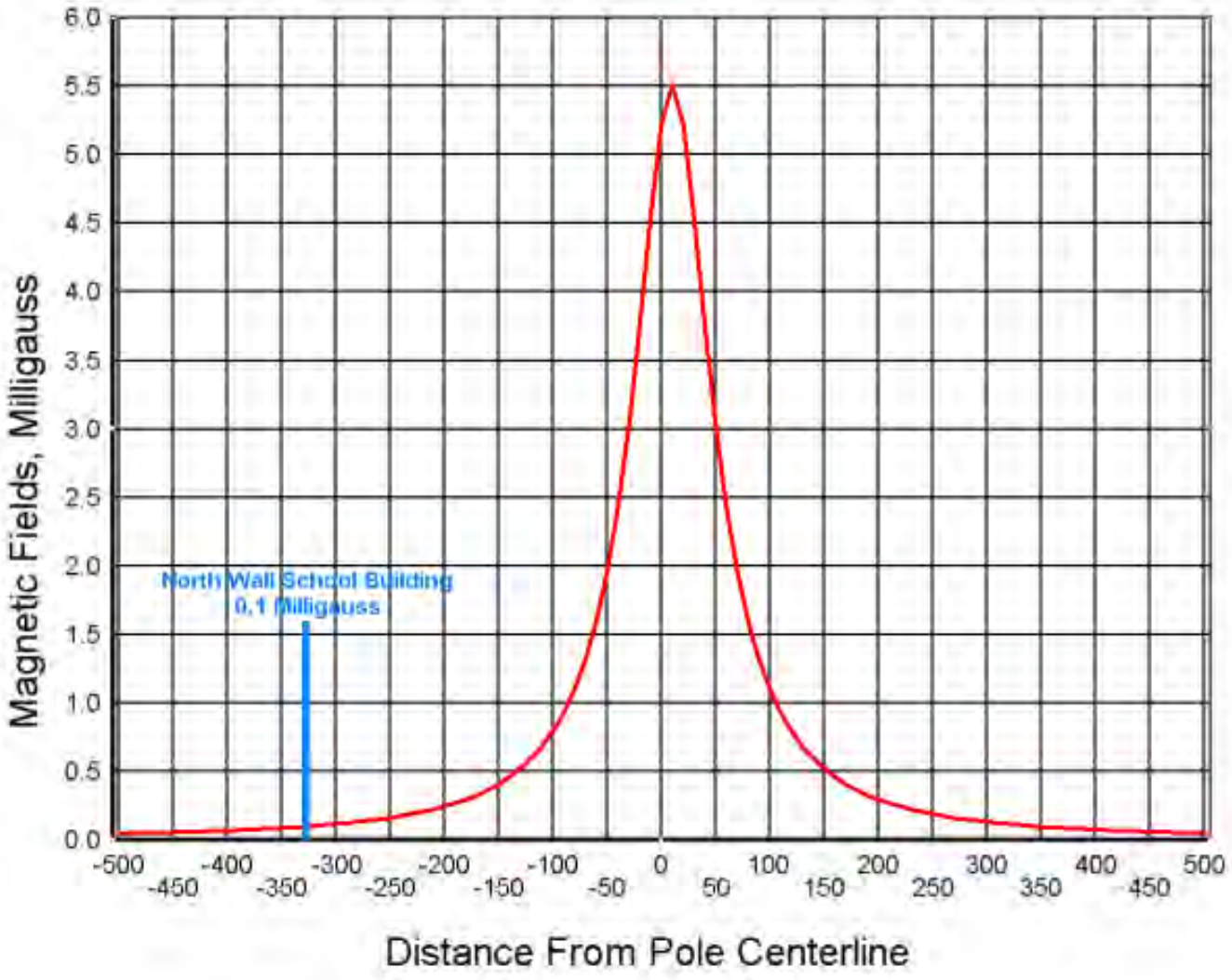
Studies of other childhood cancers have generally not found any strong links to ELF electric or magnetic fields.

In adults

Most studies in adults have not found links between ELF magnetic fields and cancer.

Magnetic Fields

Mill Creek - Perche 161-kV Transmission Line



COLUMBIA WATER & LIGHT

Discussion

Transmission corridor in Chesterfield, MO
On Clarkson Road by Marquette High School