Community Assistantship Program
...a program of the Center for Urban and Regional Affairs (CURA)

Crow Wing County’s Lakeshore Impervious Coverage Research Project

Prepared in partnership with
Crow Wing County
Land Services Department

Prepared by
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Research Assistant
University of Minnesota

2012

CAP Report # 173

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Table of Contents

I. Executive Summary.....................................................4
II. Purpose.................................................................4
III. Process.................................................................5
IV. Results.................................................................6
V. Appendices.............................................................7
I. Executive Summary

The purpose of the 2012 impervious coverage research project was to determine the amount of impervious surfaces on lakeshore parcels for parcels on lakes over 1000 acres in size. The percent impervious was calculated for the entire riparian lot. The percent impervious was also calculated within 250 feet and 500 feet of the riparian lot. The percent of impervious surfaces was calculated using high resolution Lidar and aerial photography in ESRI’s ArcMap software.

The final product of the impervious coverage study is a comprehensive Geographic Information System (GIS) layer of different surfaces and a calculation of the percent impervious by parcel on the selected lakes. This will help Crow Wing County in its water planning efforts, especially in regards to the effects of stormwater management. It will also help with determining what land use performance standards may be needed for future permit applicants.

II. Purpose

Water is Crow Wing County’s lifeblood. The county has an area of 731,000 acres and approximately 102,000 acres or 14% is covered by over 400 scenic lakes, rivers, and streams. An additional 14% is covered by wetlands as well. The abundance of surface water makes this Central Minnesota County an attraction to people.

From 1990 to 2000 the population in Crow Wing County has increased by 24.5%, the eleventh fastest growth county of Minnesota’s 87. The most recent census shows the population continued to grow another 13.4% from 2000 to 2010. The majority of the growth is concentrated around the clear, deep water lakes where seasonal cabins are being replaced with larger year-round homes. With these larger homes comes the potential for more stormwater runoff into these majestic lakes.
Crow Wing County revised its Land Use Ordinance in 2011. This ordinance placed added performance standards based on the amount of impervious surfaces per lot. It is now required to have a storm water management plan if the riparian lot exceeds 15% in impervious surfaces. The ordinance prohibits more than 25% impervious surfaces in the shoreland protection zone (Article 41). This ordinance will help keep lakes clean for generations to come.

<table>
<thead>
<tr>
<th>Development or Use</th>
<th>Maximum Impervious Surface</th>
<th>Applicable Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential lots-with no stormwater plan required as per Article 41.2.1 A</td>
<td>15%</td>
<td>Total lot area above the OHW</td>
</tr>
<tr>
<td>Residential lots with stormwater plan as per Article 41.2.1 B</td>
<td>20%</td>
<td>Total lot area above the OHW</td>
</tr>
<tr>
<td>Residential lots with stormwater plan &amp; shoreline buffer as per Article 41.2.1 C</td>
<td>25%</td>
<td>Total lot area above the OHW</td>
</tr>
<tr>
<td>Conservation Developments with stormwater plans as per Article 41.3</td>
<td>30%</td>
<td>Average Dwelling unit lot above the OHW</td>
</tr>
<tr>
<td>Resorts with stormwater plans as per Article 34.8</td>
<td>25%</td>
<td>Total project area and any tier above the OHW</td>
</tr>
<tr>
<td>Commercial with stormwater plans as per Article 16.3</td>
<td>30%</td>
<td>Total lot area above the OHW</td>
</tr>
</tbody>
</table>

This study defines the percent of impervious surfaces on individual lots. It is needed to maintain the integrity and build the foundation for future studies. We as individuals need to realize that our planning today will make a huge impact on the future. It does not take long to damage our natural resources, such as these waterways and lakes, but it will take generations to get them back to the way they are today.

III. Process

The study began with Chris Pence (Land Services Supervisor), David Landecker (Survey Coordinator), and Mitch Brinks (Water Protection Specialist), all from the Crow Wing County Land Services Department, instructing me on the information needed for this study. The information needed was the amount of impervious surfaces within 500 feet of the Ordinary High Water. They wanted to know the different kinds of impervious surfaces such as bituminous driveways, gravel driveways, dirt driveways, grass driveways, boathouses, dwellings, sheds, garages, patios, and so on. This information will help determine future updates to the local water plan.
Using ArcMap, I created different layers for all the different kinds of impervious surfaces and began digitizing them. Layers are used to display and work with a specific GIS dataset. A layer in ArcMap represents geographical data such as a particular theme and in this case it is the impervious surfaces. In certain instances, it was impossible to see the entire building on the aerial photo. In these instances I had to use county records to find out the dimensions of the structure. The Property Valuation and Classification Office has records on all the structures in the county. Using this information I could determine the percent of impervious per lot.

In extreme instances, where aerial photography and high resolution Lidar could not be used, I would have to do some ground truthing to determine the impervious coverage. I used a Geo Explorer 6000 GPS unit to calculate the amount of impervious. I also needed to ground truth parcels that were completed using ArcMap. The reasoning for this was to determine how accurate the calculations are by using the GIS software.

IV. Results

To confirm that the interpreted computed calculations would be correct using this software I had to ground truth several parcels. During the ground truthing process, I used a Geo Explorer 6000 GPS unit to calculate the percent of impervious surfaces and then compared them with the findings in ArcMap. The parcels that were ground truthed established that the percent impervious range was 0-2% from the calculated percent using the ArcMap software. We found this to be an acceptable level of deviation. Now that we have this data we can continue to track the percent of impervious on these lakes to determine future plans for this growing county.
V. Appendices

<table>
<thead>
<tr>
<th>Lake Name</th>
<th># of Riparian Lots Per Lake</th>
<th>% Imp Within 250' of OHW</th>
<th>% Imp Within 500' of OHW</th>
<th>Average % Imp Per Lot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borden</td>
<td>236 Lots</td>
<td>5.0%</td>
<td>4.1%</td>
<td>2.8%</td>
</tr>
<tr>
<td>Platte</td>
<td>340 Lots</td>
<td>5.2%</td>
<td>4.0%</td>
<td>2.3%</td>
</tr>
<tr>
<td>Upper Hay</td>
<td>303 Lots</td>
<td>8.6%</td>
<td>8.0%</td>
<td>5.6%</td>
</tr>
<tr>
<td>Lower Hay</td>
<td>202 Lots</td>
<td>6.8%</td>
<td>6.7%</td>
<td>5.9%</td>
</tr>
<tr>
<td>Bertha</td>
<td>173 Lots</td>
<td>10.7%</td>
<td>11.4%</td>
<td>10.5%</td>
</tr>
<tr>
<td>Pig</td>
<td>86 Lots</td>
<td>3.1%</td>
<td>2.4%</td>
<td>1.9%</td>
</tr>
<tr>
<td>Arrowhead</td>
<td>44 Lots</td>
<td>1.9%</td>
<td>2.0%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Big Trout**</td>
<td>88 Lots</td>
<td>7.1%</td>
<td>7.0%</td>
<td>5.4%</td>
</tr>
<tr>
<td>Rush**</td>
<td>57 Lots</td>
<td>12.7%</td>
<td>13.7%</td>
<td>13.7%</td>
</tr>
<tr>
<td>Hubert**</td>
<td>122 Lots</td>
<td>11.8%</td>
<td>9.0%</td>
<td>6.4%</td>
</tr>
<tr>
<td>Round**</td>
<td>219 Lots</td>
<td>13.0%</td>
<td>14.6%</td>
<td>14.5%</td>
</tr>
<tr>
<td>Whitefish**</td>
<td>745 Lots</td>
<td>6.3%</td>
<td>6.2%</td>
<td>4.8%</td>
</tr>
</tbody>
</table>

** Some parcels not included because they are located inside city limits.
Impervious Surfaces (by type)

- Boathouse
- Driveway-Cement/Asphalt
- Driveway-Dirt/Gravel
- Driveway-Grass
- Dwelling
- Garage
- Miscellaneous
- Patio/Landscaping
- Shed
- Roads
- Parcels
- Lakes

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Total Impervious Coverage for all Lots = 1.7%
Total Impervious Coverage within 500 ft = 2.0%
Total Impervious Coverage within 250 ft = 1.9%

Arrowhead Lake

Impervious Surface Coverage by Parcel

Environmental Services

Miles
Arrowhead Lake

Impervious % within 500 ft of Shoreline

- 0 - 15%
- 15 - 20%
- 20 - 25%
- 25+

Total Impervious Coverage for all Lots = 1.7%
Total Impervious Coverage within 500 ft = 2.0%
Total Impervious Coverage within 250 ft = 1.9%
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Environmental Services

Total Impervious Coverage for all Lots = 1.7%
Total Impervious Coverage within 500 ft = 2.0%
Total Impervious Coverage within 250 ft = 1.9%

Arrowhead Lake

Impervious % within 250 ft of Shoreline

- 0 - 15 %
- 15 - 20 %
- 20 - 25 %
- 25+ %

- Section Lines
- Roads
- Lakes

Arrowhead Lake

Arrowhead (18-366 P)

Mud (18-353 W)

Whitefish (18-310 P)

SANDY TRL

HOLLY

SUNSET SHRS

FATHER FOLEY DR

CO RD 1

CO RD 134

ARROWHEAD CT

ARROWHEAD DR

WARROWHEAD DR

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Total Impervious Coverage for all Lots = 1.7%
Total Impervious Coverage within 500 ft = 2.0%
Total Impervious Coverage within 250 ft = 1.9%

Arrowhead Lake

Impervious % within 250 ft of Shoreline

- 0 - 15 %
- 15 - 20 %
- 20 - 25 %
- 25+ %

- Section Lines
- Roads
- Lakes

Arrowhead Lake

Arrowhead (18-366 P)

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Total Impervious Coverage for all Lots = 1.7%
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Total Impervious Coverage within 250 ft = 1.9%

Arrowhead Lake
Lake Bertha

Impervious Surface Coverage by Parcel

- Total Impervious Coverage for all Lots = 10.5%
- Total Impervious Coverage within 500 ft = 11.4%
- Total Impervious Coverage within 250 ft = 10.7%

- Roads
- Section Lines
- Lakes

0 - 15 %
15 - 20 %
20 - 25 %
25+ %

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Environmental Services

Lake Bertha

Total Impervious Coverage for all Lots = 10.5%
Total Impervious Coverage within 500 ft = 11.4%
Total Impervious Coverage within 250 ft = 10.7%

Impervious % within 500 ft of Shoreline:
- 0 - 15%
- 15 - 20%
- 20 - 25%
- 25+%

Roads
Section Lines
Lakes
Total Impervious Coverage for all Lots = 10.5%
Total Impervious Coverage within 500 ft = 11.4%
Total Impervious Coverage within 250 ft = 10.7%

Lake Bertha

Impervious % within 250 ft of Shoreline

0 - 15 %  
15 - 20 %  
20 - 25 %  
25+ %  

Roads  
Section Lines  
Lakes  

Environmental Services

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Total Impervious Coverage for all Lots = 5.4%
Total Impervious Coverage within 500 ft = 7.0%
Total Impervious Coverage within 250 ft = 7.1%
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Environmental Services

Impervious % within 500 ft of Shoreline

- Big Trout Lake
- Total Impervious Coverage for all Lots = 5.4%
- Total Impervious Coverage within 500 ft = 7.0%
- Total Impervious Coverage within 250 ft = 7.1%
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Environmental Services

Borden Lake

Total Impervious Coverage for all Lots = 2.8%
Total Impervious Coverage within 500 ft = 4.1%
Total Impervious Coverage within 250 ft = 5.0%

Impervious Surface Coverage by Parcel

- 0 - 15%
- 15 - 20%
- 20 - 25%
- 25+%

Roads
Section Lines
Lakes
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Environmental Services

Impervious % within 500 ft of Shoreline

Total Impervious Coverage for all Lots = 2.8%
Total Impervious Coverage within 500 ft = 4.1%
Total Impervious Coverage within 250 ft = 5.0%
Total Impervious Coverage for all Lots = 2.8%
Total Impervious Coverage within 500 ft = 4.1%
Total Impervious Coverage within 250 ft = 5.0%
Environmental Services

Lake Hubert

Impervious Surface Coverage by Parcel

- 0 - 15%
- 15 - 20%
- 20 - 25%
- 25+%

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- Total Impervious Coverage for all Lots = 6.4%
- Total Impervious Coverage within 500 ft = 9.0%
- Total Impervious Coverage within 250 ft = 11.8%
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Lake Hubert

Impervious % within 500 ft of Shoreline

- 0 - 15 %
- 15 - 20 %
- 20 - 25 %
- 25+ %

Roads
Section Lines
Lakes

Total Impervious Coverage for all Lots = 6.4%
Total Impervious Coverage within 500 ft = 9.0%
Total Impervious Coverage within 250 ft = 11.8%
Total Impervious Coverage for all Lots = 6.4%
Total Impervious Coverage within 500 ft = 9.0%
Total Impervious Coverage within 250 ft = 11.8%
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Environmental Services

Impervious Surface Coverage by Parcel

- Total Impervious Coverage for all Lots = 5.9%
- Total Impervious Coverage within 500 ft = 6.7%
- Total Impervious Coverage within 250 ft = 6.8%
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Lower Hay Lake

Total Impervious Coverage for all Lots = 5.9%
Total Impervious Coverage within 500 ft = 6.7%
Total Impervious Coverage within 250 ft = 6.8%

Impervious % within 500 ft of Shoreline
- 0 - 15%
- 15 - 20%
- 20 - 25%
- 25+%

Section Lines
Roads
Lakes

Environmental Services
CROW WING COUNTY

0 0.25 0.50.125
Miles
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Impervious Coverage:

Total Impervious Coverage for all Lots = 5.9%
Total Impervious Coverage within 500 ft = 6.7%
Total Impervious Coverage within 250 ft = 6.8%

Environmental Services

Crow Wing County

Lower Hay Lake
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Total Impervious Coverage for all Lots = 1.9%
Total Impervious Coverage within 500 ft = 2.4%
Total Impervious Coverage within 250 ft = 3.1%

Impervious Surface Coverage by Parcel

0 - 15 %  
15 - 20 %  
20 - 25 %  
25+ %

Roads  
Section Lines  
Lakes

Pig Lake
Total Impervious Coverage for all Lots = 1.9%
Total Impervious Coverage within 500 ft = 2.4%
Total Impervious Coverage within 250 ft = 3.1%
Environmental Services

Pig Lake

Total Impervious Coverage for all Lots = 1.9%
Total Impervious Coverage within 500 ft = 2.4%
Total Impervious Coverage within 250 ft = 3.1%

Impervious % within 250 ft of Shoreline

- 0 - 15 %
- 15 - 20 %
- 20 - 25 %
- 25+ %

0.05 0.1 0.2 Miles

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Environmental Services

Impervious Surface Coverage by Parcel

- Total Impervious Coverage for all Lots = 2.3%
- Total Impervious Coverage within 500 ft = 4.0%
- Total Impervious Coverage within 250 ft = 5.2%

- Platte Lake

Platte (18-88 P)
Rock (18-16 P)
Mud (18-10 P)
Erskine (18-9 P)
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Environmental Services

Imperious % within 500 ft of Shoreline

- 0 - 15%
- 15 - 20%
- 20 - 25%
- 25+%

Total Imperious Coverage for all Lots = 2.3%
Total Imperious Coverage within 500 ft = 4.0%
Total Imperious Coverage within 250 ft = 5.2%
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Platte (18-88 P)
Rock (18-16 P)
Mud (18-10 P)
Erskine (18-9 P)

Environmental Services

Impervious % within 250 ft of Shoreline

- 0 - 15 %
- 15 - 20 %
- 20 - 25 %
- 25+ %

Platte Lake

Total Impervious Coverage for all Lots = 2.3%
Total Impervious Coverage within 500 ft = 4.0%
Total Impervious Coverage within 250 ft = 5.2%
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Environmental Services

Impervious Surface Coverage by Parcel

- 0 - 15%
- 15 - 20%
- 20 - 25%
- 25+%

Round Lake

- Roads
- Section Lines
- Lakes

Total Impervious Coverage for all Lots = 14.5%
Total Impervious Coverage within 500 ft = 14.6%
Total Impervious Coverage within 250 ft = 13.0%
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Environmental Services

Impervious % within 500 ft of Shoreline
- 0 - 15%
- 15 - 20%
- 20 - 25%
- 25+%}

Total Impervious Coverage for all Lots = 14.5%
Total Impervious Coverage within 500 ft = 14.6%
Total Impervious Coverage within 250 ft = 13.0%
Round Lake

Impervious % within 250 ft of Shoreline

- 0 - 15%
- 15 - 20%
- 20 - 25%
- 25+

Roads
Section Lines
Lakes

Total Impervious Coverage for all Lots = 14.5%
Total Impervious Coverage within 500 ft = 14.6%
Total Impervious Coverage within 250 ft = 13.0%

Environmental Services

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Rush Lake

Total Impervious Coverage for all Lots = 13.7%
Total Impervious Coverage within 500 ft = 13.7%
Total Impervious Coverage within 250 ft = 12.7%

Impervious % within 500 ft of Shoreline:
- 0 - 15 %
- 15 - 20 %
- 20 - 25 %
- 25+ %

Environmental Services

CROW WING COUNTY

DWY BEACON SHORES RESORT
HILLCREST HTS
WHITEFISH (18-310 P)
RUSH (18-311 P)
SILOVER
PEAK RD
HARBOR LN
MILINDA SHORES RD
CAMELIA
HARBOR TRL
HILLCREST HTS
DWY - GOLDEN HARBOR MHPARK
DWY - PEACFULL HARBOR MHPARK
LYNN BOYD WAY
RONA SHORES CIR
SHORES CI
S CR
DWB - GOLDEN HARBOR MHPARK
DWB - PECOLL HARBOR MHPARK
DWY BEACON SHORES RESORT
HILLCREST HTS
WHITEFISH (18-310 P)
RUSH (18-311 P)
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Environmental Services

Impervious % within 250 ft of Shoreline

- 0 - 15 %
- 15 - 20 %
- 20 - 25 %
- 25+ %

Roads
Section Lines
Lakes

Total Impervious Coverage for all Lots = 13.7%
Total Impervious Coverage within 500 ft = 13.7%
Total Impervious Coverage within 250 ft = 12.7%

Rush Lake

Impervious % within 250 ft of Shoreline

0 500 1,000
Feet

Dwy - Golden Harbor MP
Dwy - Peaceful Harbor MP
Rush (18-311 P)
DWY Beacon Shores Resort
Silver Peak Rd
Hillcrest Hts
Lynn Boyd Way
Milinda Shores Rd
Dwy - Peacful Harbor MP Park
Lakes
Roads
Section Lines
Lakes

Habour Ln
Habour Ln
Came"a
Harbor Ln
Habour Ln
Came"a
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Total Impervious Coverage for all Lots = 5.6%
Total Impervious Coverage within 500 ft = 8.0%
Total Impervious Coverage within 250 ft = 8.6%
THIS DRAWING IS A COMPILATION OF RECORDS AS THEY APPEAR IN THE CROW WING COUNTY OFFICES AFFECTING THE AREA SHOWN AND IS TO BE USED ONLY FOR REFERENCE PURPOSES. THE COUNTY IS NOT RESPONSIBLE FOR ANY INACCURACIES HERIN CONTAINED.

Upper Hay Lake

Total Impervious Coverage for all Lots = 5.6%
Total Impervious Coverage within 500 ft = 8.0%
Total Impervious Coverage within 250 ft = 8.6%

Impervious % within 500 ft of Shoreline

0 - 15%  Section Lines
15 - 20%  Roads
20 - 25%  Lakes
25+ %
THIS DRAWING IS A COMPILATION OF RECORDS AS THEY APPEAR IN THE CROW WING COUNTY OFFICES AFFECTING THE AREA SHOWN AND IS TO BE USED ONLY FOR REFERENCE PURPOSES. THE COUNTY IS NOT RESPONSIBLE FOR ANY INACCURACIES HERIN CONTAINED.

Total Impervious Coverage for all Lots = 5.6%
Total Impervious Coverage within 500 ft = 8.0%
Total Impervious Coverage within 250 ft = 8.6%

Upper Hay Lake

Impervious % within 250 ft of Shoreline

0 - 15%  15 - 20%  20 - 25%  25+%

Section Lines  Roads  Lakes
This drawing is a compilation of records as they appear in the Crow Wing County offices affecting the area shown and is to be used only for reference purposes. The county is not responsible for any inaccuracies herein contained.
This drawing is a compilation of records as they appear in the Crow Wing County Offices affecting the area shown and is to be used only for reference purposes. The county is not responsible for any inaccuracies herein contained.

Total Impervious Coverage for all Lots = 4.8%
Total Impervious Coverage within 500 ft = 6.2%
Total Impervious Coverage within 250 ft = 6.3%

Whitefish Lake (West)
This drawing is a compilation of records as they appear in the Crow Wing County offices affecting the area shown and is to be used only for reference purposes. The county is not responsible for any inaccuracies herein contained.

Environmental Services

Impervious Surface Coverage by Parcel

Whitefish Lake (East)

- Total Impervious Coverage for all Lots = 4.8%
- Total Impervious Coverage within 500 ft = 6.2%
- Total Impervious Coverage within 250 ft = 6.3%

Legend:
- Green: 0 - 15%
- Yellow: 15 - 20%
- Orange: 20 - 25%
- Red: 25+
- Roads
- Section Lines
- Lakes

Environmental Services
This drawing is a compilation of records as they appear in the Crow Wing County Offices affecting the area shown and is to be used only for reference purposes. The County is not responsible for any inaccuracies herein contained.

Environmental Services
Environmental Services

Impervious % within 500 ft of Shoreline

Whitefish Lake (East)

- Total Impervious Coverage for all Lots = 4.8%
- Total Impervious Coverage within 500 ft = 6.2%
- Total Impervious Coverage within 250 ft = 6.3%
This drawing is a compilation of records as they appear in the Crow Wing County Offices affecting the area shown and is to be used only for reference purposes. The County is not responsible for any inaccuracies herein contained.

Impervious % within 250 ft of Shoreline

Total Impervious Coverage for all Lots = 4.8%
Total Impervious Coverage within 500 ft = 6.2%
Total Impervious Coverage within 250 ft = 6.3%

Environmental Services

Whitefish Lake (East)