

**Appendix D:**Revised Impervious Cover Methodology---May 2006

The West Fork Clear Creek IC methods took too long. In order for this process to be as efficient and effective as possible, we need to find a way to cut down on the time needed for IC determination. (One should be able to get at least 2 catchments done per semester.) The process should also be easy to carry out and to explain to future interns/analysts.

The zoning layer will serve as the initial basis for current land use, in addition to being used unchanged for determining future IC. This will allow for more direct comparability between current and future IC, which we were unable to do with the earlier method used in the WFCC report. We will use the zoning coefficient translation spreadsheet for both the current and future IC estimates (Table 1).

New aerial photography will not affect the accuracy of sampling. Although important in the final IC calculation, the amount of a certain land use does not directly impact IC coefficient determination, other than during the random parcel selection for digitizing our own coefficients. This random selection may be carried out in a non-statistically defensible manner (with random number generation, etc.), but may be selected at “random” by the GIS operator.

**Step-by-step Instructions for NEW IC analysis:**

1. Start a new ArcMap project, adding MC boundaries, townships, raster aerial photo for the county found on the SDE (2005 aerial is most current as of May 2006). Also add Hydrologic Unit Code (HUC) 6, 8, 11, and 14 to get context. See Hoosier Riverwatch manual for further watershed/catchment explanation (p.7-8).

Layers to be added:

Layers can be found on the N drive in the GIS/data folder, OR on the SDE server, both vector and raster data. (Become familiar with the GIS data files on the N drive as they are frequently updated, moved between folders, etc.)

MC catchments
MC boundaries
Townships
Aerial photo (2005 or most recent)
HUC 6, 8, 11, 14
State roads
Road centerlines
Hydrology
MC waters with Griffy
Floodplain
“county AND city zoning combined working, with subtractions”
“Parcels.new.edits”

2. Create a new folder for each catchment to contain clips. This folder should be located in the “Sub-watersheds – Catchments” folder.
3. Digitize catchment if not already been done (see county catchments geodatabase-from Marianne (MC catchments))
4. Manipulate symbology to show each catchment, select particular catchment, create new layer from selection, and export selection of catchment as a layer file (ask Jason if needed)
5. Clip centerlines, hydrology, parcels.new.edits, and floodplain layers to particular catchment (should save in folder created in #2)
6. Clip combined city and county zoning layer to catchment (county AND city zoning combined working, with subtractions)
  - a. Rectify gap situation (Tag: GAPS-ERASE???) Gaps (created during the initial union of the city and county files in Dec. 2005) found in the combined city and county zoning layers file should be assessed on a catchment by catchment basis, depending on the adjacent zoning classification and the observed (from aerial photographs) land use.
7. Clip the parcels.new.edits layer to the catchment. “parcels.new.edits” is the most updated and current parcel layer. Use this one!! Found on the SDE server.
8. Combine this clip (parcels.new.edits/catchment) and the clipped zoning layer using the union function
9. Re-calculate area and acreage, just to make sure nothing got messed up in manipulation. (Get used to doing this calculation and do it frequently. Every time a toolbox function is used (i.e. clip, union, etc.) previously calculated acreage becomes questionable and should be re-calculated when accurate acreage is needed.)
  - a. Area calculations:
    - i. Area (sq ft): search under “Area” in the ArcGIS help index.
      - a. Create new attribute column. [Editing must be off].
      - b. Select “Double” for type.
      - c. Turn on Editing.
      - d. Click on the attribute column → Right click → Calculate values
      - e. Select the “Advanced” checkbox
      - f. In the first and larger text box, enter this code:  
**Dim dblArea as double**  
**Dim pArea as IArea**  
**Set pArea = [shape]**  
**dblArea = pArea.area**
      - g. In the second and smaller text box, enter “**dblArea**” (The code in f and g can also be found in ArcMap Help.)
    - ii. Acreage:
      - a. Create new attribute column. [Editing must be off].
      - b. Select “Float” for type.
      - c. Turn on Editing.
      - d. Click on the attribute column → Right click → Calculate values
      - e. De-select the “Advanced” checkbox

- f.  $\text{Acreage} = [\text{Area}]/43560$
10. Create a new field named “Current\_IC” in the attribute table of the catchment specific zoning/parcels layer just created.
  11. Some extraneous fields may be deleted for better manageability, but this is not totally necessary. If doing this, make sure to keep address and property description fields, etc.

*Assessing Current Impervious Cover via land use assessment.*

12. Turn on editing for the zoning/parcels layer.
13. Using the combined parcels and zoning layer for the catchment, start looking at the zoning and the aerial photos together. Determine any differences between the zoning and what is visible on the aerial photo. If there is no difference, enter the CWP\_class in the Current\_IC column. If there is a difference, enter the classification tag that matches the land use visible from the aerial photo, according to the instructions in 14.
  - a. To assign a land use (or any attribute) to a set of (more than one) selected features: **(Very useful!)**
    - i. First, make sure Editing is on.
    - ii. Select the desired features (by Attribute, Location, etc.)
    - iii. Go to map view.
    - iv. Using the black arrow from the editor toolbar, point to any of the selected features and right click.
    - v. Select “Attributes” from the menu. The list of all the selected features will be visible.
    - vi. To enter an attribute for the entire set, click on the layer name (at the very top). The attributes will be listed without values.
    - vii. Click on the value field for the desired attribute and enter the value. The value you enter will disappear, but click on any item in the list to make sure it worked.
14. Select all full parcels in a zoning area. Zoning categories will be the basis for selecting groups of parcels. Within these parcels, an average acreage will be calculated for parcels with the dominant type of land use (residential, etc.). This average will fall within a certain land use category with associated IC coefficient (Table 1). This category and associated coefficient will be applied to the entire block of parcels in that zoning area. This will eliminate the need to cut road parcels to individual parcels, although road parcels will still need to be cut for these larger current IC areas. (See Roads section) Further explanation of the particular categories follows.
  - a. Residential:
    - i. A classification of “R4” for current impervious cover includes residential parcels less than 0.07 acres, in addition to those between 0.07 and 0.139 acres. This is mainly due to the presence of partial parcels when the watershed boundary cuts across parcel lines.
    - ii. When current impervious cover classification is determined based primarily on acreage, such acreage is rounded to 2 decimal places to facilitate placement in IC categories.

- iii. Mobile /manufactured housing is treated the same as other residential categories (determined by acreage classification).
  - iv. The Rural Residential category will remain as is or will be divided into different acreage categories. This determination will be at analyst's discretion based on the acreage range of RR parcels in some of the more rural catchments.
- b. PUD:
- i. To determine the average acreage of a PUD zoned section, all parcels shall be included that fall completely within the watershed. Partial parcels shall be included in this average acreage calculation only if all or most of the building/structure found on the parcel is within the watershed. This is rather intuitive and will be obvious once you see the parcels clipped to the catchment; moreover, including these tiny partial parcels would distort the average. The partial parcels not included in the average acreage calculation will still receive the land use and associated coefficient as the rest of the PUD parcels in that section.
  - ii. When calculating the average acreage for residential PUDs, common areas (recreational areas, neighborhood pool complexes, etc) should be included.
  - iii. Parcels that are so large as to shift the section to a different IC category should be assessed on an individual basis and may be assessed separately from the PUD within which they fall, at the analyst's discretion.
  - iv. Mixed use PUDs will be difficult and may need to be assessed as two or more different areas depending on the particular situation. Again, analyst discretion is required and it may be appropriate to consult Jason Eakin/planner for PUD specific clarification.
  - v. PUD zones in the future IC calculation should be assessed in the same way as the current calculation, by determining the type of land use (based on acreage if necessary) and applying the associated coefficient.
- c. Roads
- i. To most accurately assess impervious cover, we must include roads in our acreage totals for each land use type. This is because the impervious cover coefficients adopted from C&B were determined including roads in the particular type of land use. Parcels shown to contain road area within parcel boundaries will be assessed as is. For parcels not including any road area within parcel boundaries, existing road parcels will be cut to their associated blocks of land use parcels as determined by the previous methods. This method was chosen over the previously considered "buffer method" because of the apparent discontinuity between the parcel boundaries layer and the aerial photography. Some parcels overlap road structures and others do not. Some roads parcels do not line up exactly with the road as it appears in the aerial photo.
  - ii. Future impervious cover will deal with roads in the same way because even if we cut roads from zoning and applied our own

coefficients based on the Thoroughfare Plan, we would still have to “subtract” the roads portion of the coefficients applied to zoning so as not to double count roads in the final FIC value.

- iii. Roads are already considered for future impervious cover because the coefficients incorporated roads during their creation.
- iv. Some step-by-step instructions to include adjacent road sections:
  - a. Select the road parcel
  - b. Make sure Editor is on
  - c. “Task” should be “Cut polygon features”
  - d. Make sure the “Target” is set to the proper layer you want to edit
  - e. Turn on snapping for the road centerlines and parcels layers
  - f. Select the road parcel you want to cut
  - g. Draw a line where you want to bisect the road parcel, then double-click
    - i. *You cannot cut a polygon if it is not selected!*
- d. Institutional
  - i. Zoning areas will be viewed individually to confirm that, for example, there is actually agricultural land in an AG zoning area. If there are undeveloped areas in this zoning area, a division will be made between the developed and undeveloped areas. Such divisions will be made along parcel lines, not within parcels themselves.
  - ii. The Community Business future IC category has been modified/renamed Institutional with divisions of particular land uses as listed in C&B Table 4.3. For the areas in current IC we shall use the institutional categories provided in C&B Table 4.3. An average of these institutional categories will be used for current unbuilt institutional areas, because we do not know what such areas will actually become in the future; they could basically become anything. Future Institutional land areas will also employ the coefficients found in Table 4.3.
- e. Chapter 802 of the MC Zoning Ordinance should be used for determining unknown land uses that have been “cut” from the zoning layer.
- f. Quarry
  - i. Quarry parcels will still be assessed individually and impervious cover determined from digitization of each parcel. This will be done on a catchment by catchment basis as such parcels come up.
  - ii. The same coefficients as calculated for current IC shall be used for future IC. The reasoning behind this is that quarry expansion is minimal and most likely to remain similar to current amounts.
- g. Other than the categories described above, the coefficients set forth in C&B shall be used. See translation spreadsheet Table 1.

*Once the entire catchment has been completed for Current\_IC and roads have been cut to the appropriate adjacent parcels, the impervious cover percentage can be calculated.*

15. Copy the excel spreadsheet, catchment\_IC\_calculations from one of the previously assessed catchments, renaming it appropriately and deleting the acreage values in each worksheet.
16. Re-calculate area in the catchment\_zoning and parcels layer
17. Select by attributes in the attribute table for each Current\_IC class in the layer.
18. Right click on the Acreage column, find statistics, and enter the “sum” value into the catchment\_IC\_calculations spreadsheet next to each Current\_IC class. The final current IC percentage will be calculated automatically.

*Future impervious calculations do not take as long as current because they are based on the existing zoning information and do not require extensive class translations.*

19. Copy the current IC ArcMap project and rename it catchment\_Future IC.
20. Create a new field in the catchment floodplain layer called “floodplain” and enter “yes” into all fields in that layer.
21. Using the Union tool in the Toolbox, combine the catchment floodplain and catchment zoning layers. Name the resulting file catchment\_future IC in the catchment data folder.
22. In the catchment\_future IC attribute table, select by floodplain attributes all the entries with “yes.” Enter FL into the CWP\_class field in the attribute table using the technique described in 13 above. The resulting layer will be zoning with floodplain areas noted.

*PUD zones present a problem with the previously described method of IC calculation, mainly because the “variable” class does not have an associated impervious cover coefficient. To address this problem, future IC for PUDs requires a bit more work than the other classes, which have been assigned a coefficient already. There is the additional problem that without any zoning-specific coefficients, no land use v. zoning distinction is possible. As such, future PUDs will be assessed with the same coefficients as current PUDs. To accomplish this...*

23. Make sure you are familiar with switching between selectable layers (specifically current and future IC for a particular catchment).
24. For all zones with a “variable” CWP\_class, identify the class that the PUD was assigned in the current IC calculation, selecting between the current and future IC layer attribute tables. (Alternately, if the PUD zones are easily identified and not too numerous, open the Catchment\_Current IC project in a different window and toggle between the two.) Enter this current class into the CWP\_class field in the future\_IC attribute table.
25. Once this is completed for all PUD/variable zones, calculate future IC as described in 16-18 above.
26. Adjust parcels for Roads as described above in 14.c. Again, this needs to be done only for roads that run on the borders between two zoning classes.
27. Calculate the future impervious cover as described in 16-18 above.

**Table 1: Zoning (City and County) Translation to Impervious Cover Coefficients**

FIC%	CIC%	Description (acres)	future land use	abr.	city zoning	abr.	COUNTY ZONING LAYER			
					(as is in layer)		county zoning	abr.	former fringe zoning	abr.
1.9	1.9	5 --> (for FR)	Agriculture	AG			Forest Reserve	FR		
10.6	10.6	2.5 -->	Rural Residential	RR			Agriculture/Rural Reserve, Conservation Residential	AG/RR, CR	Estate Residential (2.5)	RE2.5
14.3	14.3	1-2.49	Residential District	R	Estate Residential 1	RE1	Estate, Suburban, and Low Density Residential	ER, SR	Estate Residential (1)	RE1
21.2	21.2	0.5-0.99	Urban Residential	R1	Single Dwelling Residential	RS2	Low Density Residential	LR	Single Dwelling Residential	RS2
27.8	27.8	0.26-0.49	Urban Residential	R2			Medium Density Residential	MR	Single Dwelling Residential	RS4.5, RS3.5
30	30	0.14-0.25	Urban Residential	R3	Low Density Multi Dwelling Residential	RM7	High Density Residential	HR	Low Density Multi Dwelling Residential, Townhouse Residential	RT7, RM7
32.6	32.6	0.07-0.139	Urban Residential	R4	High Density Multi Dwelling Residential	RM15	Urban Residential	UR	High Density Multi Dwelling Residential	RM15
44.4	44.4	0.21 -->	Residential/Office	RO	Limited Commercial	CL	Limited Business	LB	Limited Commercial	CL
72.2	72.2		Neighborhood Business	B1	Downtown Commercial	CD				
			<u>Institutional</u> (see further divisions below)	B2	Institutional	I				
21.9	NA		Unbuilt	UBI	Institutional	I	Institutional/Public	IP	Institutional	I

			Institutional							
39.9	39.9		Churches	CH	Institutional	I	Institutional/Public	IP	Institutional	I
30.3	30.3		Schools	SC	Institutional	I	Institutional/Public	IP	Institutional	I
35.4	35.4		Municipal	MU	Institutional	I	Institutional/Public	IP	Institutional	I
5	5		Golf Courses	GO	Institutional	I	Institutional/Public	IP	Institutional	I
8.3	8.3		Cemeteries	CM	Institutional	I	Institutional/Public	IP	Institutional	I
12.5	12.5		Parks	PK	Institutional	I	Institutional/Public	IP	Institutional	I
72.2	72.2		General Business	B3	Business Park, Arterial Commercial	BP, CA	General Business	GB	Arterial Commercial, General Commercial	CA, CG
53.4	53.4		General Industrial	C1	General Industrial, Heavy Industrial	IG, HI			General Industrial	
53.4	53.4		Light Industrial	L1	Limited Industrial	IL	Light Industrial	LI		
same as CIC%	custom		Quarry-all parcels should be calculated individually	Q	Quarry	Q	Mineral Extraction	ME	Quarry	Q
custom	custom								Airport Special District	AP
same as CIC%	custom*		Planned Unit Development	PUD	Planned Unit Dev.	PUD	Planned Unit Development	PUD	Planned Unit Dev.	PUD
custom	custom		Pre-Existing Business	PB	n/a		Pre-Existing Bus.	PB	n/a	
1.9	NA		Floodplain							
			*coefficient depends on type of PUD (residential, mixed use, etc.)							