

## 2016 MGIS Geog564 – Lab 5 Change Models and Core Impact Model

Assigned date: Jan 30<sup>th</sup>, 2016

Due date: Feb 8<sup>th</sup>, 2016

### **Introduction –**

In Lab03 you evaluated how well the study area currently supports the community's values. Now it is time to design the changes we might make to the study area in order that it better support those values.

For the Change Model, we adopt a very simple, quite unrealistic approach – we generate a set of projects based on the river intervals you used in Lab03 Process models. Each proposed setback action, which we will refer to as Proposed Levee Setback Projects (PLSP) follows the stream segment, but a new levee is created and setback by on either side by 300ft, giving two proposed levee offset areas per stream segment. We assume that we'd acquire the land, clear all existing content – roads, houses, commercial buildings, etc – and convert the entire site to a wetlands integrated with the river, with good tree cover along the river bank. The new levee would be built 300 ft from and parallel to the river.

In this lab you will first create a set of such LSPs along the river. Then, in the second part, you will start to look at the impacts, positive and negative, of each PLSP. On the positive side, each PLSP is assumed to stop all flooding on the same side of the river from that segment of the river. Implementing such a PLSP should then, in theory, shrink the active flood zone, thereby moving some valuable parcels (valued in the manner you defined in Lab03) out of the flood zone, while increasing wetlands and riparian conditions in the offset area. But there is a cost - the cost of all lost infrastructure of value in the offset area, and the market value of the land itself. In this Lab, you'll run a modified version of the flood zone tool from Lab 3 to see how much the flood zone shrinks for each PLSP. To cut down the workload in Lab06, you will identify for elimination those LSPs where the market value of parcels newly protected, measured by appraised land value and improvements, is significantly less than that of the parcels that the LSP's implementation would protect.

In Lab06, for each PLSP we'll calculate the change in all the criteria you developed for evaluation in Lab04, and create the final MCE decision model for the PLSPs themselves.

**Topics –** The practice of levee setbacks is bank specific in response to site specific conditions, assumptions and requirements. Flood events are modeled iteratively moving downstream in response to localized river cross sections and landscape attributes. 'Flood zones' adopts this iterative approach by merging together a series of localized mini-flood events to represent the dimension of a large scale flood. The same approach is applied to assess Proposed Levee Setback Projects (PLSP) represented as a bank specific polygon accompanied by a 'flood zone' exclusive to the side of the river occupied by each PSLP. This is an extension of the process model used before except the 'equidistant points/segments' are replaced by PSLP polygons and the 'flood zones' is delineated over a topographic surface with the river channel adjusted to enforce lateral flooding.

This change affords evaluation of PLSP / flood zone pairs, a portion of river bank repurposed to restore river system integrity and the landscape downstream that benefits from levee protection. This focus on discrete areas of the riverine landscape is accompanied by questions about relationships among PLSP sites and effective flood management outcomes. In some cases a series of levee projects may be required to insure protection of valued locations. Conversely, some portions of the landscape may only be vulnerable to flooding from a particular PLSP. This adds a third element to PLSP / flood zone pairs: the portion of the flood zone that is uniquely protected by the PLSP. Each PLSP's 'unique flood zone' (UFZ) offers another avenue for evaluation where some PSLPs will be relatively ineffective by themselves while others could have a marked reduction in the landscape exposed to flooding events.

Parcels are the spatial least common denominator to assess valuation of floodplain mitigation. Once PLSP/FZ/UFZ areas are known their characteristics can be assessed with overlay and attribute operations. It is a common Overlay work-flow to Analyze the overlay table and then Join the outcome back to one of the input overlay layers (OAJ). An example of this is acres of forest per parcel:

1. Overlay parcels and land cover polygons
2. The result is overlay polygons (OP) with parcel identification numbers (PIN), land cover codes (LCC) and polygon area (PA) attributes.
3. When there are multiple land cover codes the forest Ops must be selected with 'Select by attributes'. Unselected records for the other land covers are will be ignored.
4. To add up the forested area per parcel use 'Summarize'. To open the Summarize dialog right click on the field to summarize in the table view. In this case we want to summarize on PIN because we want to know the acres of forest in each PIN.
5. The Summarize tool dialog allows you to choose the summary statistic output to the summary result table (SRT). Since PA is a ratio level of measurement (see Stevens (1946) and Chrisman (1998)) the 'sum' statistic is valid, check the sum checkbox under the LLC field item.
6. The SRT will have at least three fields: PIN, COUNT and SUM\_PA calculated from just the selected forest records.
7. The SRT is a table separate from the polygon it belongs with. The field that connects the OP records with the SRT records is PIN. Join the SRT (from table) to the OP (to table) based on PIN.
8. You have completed the overlay, attribute operation and join (OAJ) cycle. The last thing to remember is the OP isn't a single table and the join can be a limitation to further work. Choices to resolve this is to create a new field in OP and 'calculate field' to transfer the values from the join table there. The other is to export the OP to a new feature class that will carry all the fields of both tables in one table.

While the processing part of the OAJ is repeatable it will only produce effective and applicable results if appropriate summary statistics are chosen for the attribute level of measurement being summarized. The illustration above is for the area (ratio) of a land cover category (nominal). The attributes summarized in this lab are ratio level in the form of densities (units per area).

Realize that all change has negative impacts - direct and indirect costs - that can overwhelm the intended good of the design. In the case of levee setback projects the value of the related areas protected from flooding (UFZ) are meant to exceed that of the levee project footprint (PLSP) that's repurposed to expand the natural riverine system.

**Techniques and tools** – The challenges in Lab 5 build upon the tool used so far and comes with some new/revised tools. Download Levee\_tools\_5c.zip, extract it into a new folder and load it into the ArcToolbox.

Tool: [Proposed levee setback projects (PLSP) zones]

Proposed levee setback projects (PLSP) zones replace the 'equidistant points/segments' used before at the source of flood events. The [Proposed levee setback projects (PLSP) zones] tool:

Creates zones of a desired size on the left and right of a polyline input representing 'proposed levee setback projects'. Used correctly this can be used to approximate potential areas for flood control mitigation with levee setbacks. A string character field named 'fidtxt' is a copy of the output feature class' FID field and is used as a unique identifier in subsequent analysis steps and serves as a join/key field to connect records in output tables.

Tool: [Flood zones (FZ)]

Flood zones (FZ) are unchanged from earlier work but takes on a different role in this lab vis-à-vis the input DEM surface. The change in physical model to enforce lateral flooding only on the same side of the river as the PLSP flood source is enforced by the input DEM. Rather than the river centerline being a drainage channel it has been filled in with a 1000 foot high berm (*download berm\_1000.zip from Google Drive*). This forces the modeled flood away from the channel drainage as would happen in a flood event.

Tool: [Unique flood zones (UFZ)]

‘Unique flood zones (UFZ)’ is new and for each flood zone calculates the area that is unique and not duplicated by any other flood zone.

Use ‘flood zones unique’ to identify portions of flood zones that are unique and do not overlap with other flood zone polygons. A parcel may be exposed to flooding from multiple embankment failures meaning large areas of the flood protection system will need to be improved and maintained to insure protection. Other parcels may only be exposed to flooding from embankment failure at particular locations meaning these might be well protected from a more discrete investment to improve the flood protection infrastructure. This tool takes all flow zones into account and identifies the portion of each flow zone that is unique and not redundant with flooding from other flood.

Tool:[Polygon split/merge]

‘Polygon split/merge’ is the overlay tool used to initiate the OAJ cycle. The ‘fidtxt’ field in the PLSP/FZ/UFZ feature classes is the field to enter for the required ‘split field’.

The polygon split tool (Analysis tools >> Extract >> Split) performs an iterative intersect between each split feature polygon and the input features. This is valuable in cases where there are overlaps among the split feature polygons and you still want to evaluate the intersect. The natural next step is to merge all the split polygon results into a single feature class so you can summarize the attribute table on the split feature polygon. The Split tool uses a unique id field (‘split field’) from the split feature to name to output split files. The work done by this tool is to generate a new field and write the filename into each feature for each of the split output files before they are merged.

Before you begin make sure you set ArcMap to ‘Overwrite the outputs of geoprocessing operations’ in the Geoprocessing >> Geoprocessing options dialog.

Here is minimal list of data layers you will need to start this lab.

<b>Data Layer</b>	<b>Description</b>	<b>Source (zips on Google Drive)</b>
<b>duwamish_green_LG</b>	Segmented river layer from Gene	hydro.gdb
<b>wria9_LG</b>	WRIA9 boundary from Gene	hydro.gdb
<b>berm1000</b>	DEM with a 1000ft berm along river center line	berm_1000
<b>parcel_address</b>	Original parcels layer with Appraised values (market value) fields	Parcels.gdb

It will be advantageous to be familiar with the ‘Questions and deliverables’ section below before you work through the steps that follow.

This table is an overview of the workflow in this lab. All tools are from Levee\_tools\_5c.tbx. Descriptions of the steps with dialog screenshots are in the appendix in order of appearance.

Items in purple are deliverables

Step	Task	Inputs	Methods/[tools]	Output
<b>L5 Step 1 Create PLSPs</b>	Create the Levee Setback Project (PLSP) footprints for the river	River centerline Duwamish_green_LG	PLSP zones	PLSP fc that are the flood source for creation of flood zones. The [fidtxt] field is the basis for comparison; Generate a Map of the PLSPs labeled by their fidtxt value
<b>L5 Step 2 create flood zones</b>	Create the flood zones associated with the side of the river segment of each PLSP	PLSP fc, berm_1000	“Flood zones”	Flood zones that are left/right bank specific. Create a map showing at least 4 PLSPs and their associated Flood Zones
<b>L5 Step 3 Calculate unique flood zone areas</b>	Some areas of the map may be inundated from multiple river segments – identify those areas that are only flooded from just one	Flood zones	“Unique flood zones (UFZ)”	Unique flood zones (UFZ) layer. Note ‘fidtxt’. Create a map showing at least 2 PLSPs with dramatically different UFZ areas; Briefly explain the conditions that contributed to the UFZ size difference.
<b>L5 Step 4 Calculate parcel value per sq. foot</b>	You need a parcel density field of value per square foot for assessed and improvement value to calculate the aggregate land value inside the PLSP and UFZ polygons.	parcel_address APPRLNDVAL APPR_IMPR	Add field. Field calculator	parcel_address feature class with new fields: val_sqft – ‘appraised value per sq. foot’ Briefly explain why the input value fields are unsuitable for OAJ and why the result of these attribute transformations are.
<b>L5 Step 5 Overlay PLSP and parcels</b>	Negative impact: For each PLSP, calculate the market value of the land and infrastructure destroyed were the PLSPs to be implemented	PLSP layer parcel_address as_val_sqft im_val_sqft	Polygon split/merge OAJ	PLSP joined with OAJ market value (PLSP MV) Create a Map of PLSPs symbolized by their appraised value. Write a brief summary of your OAJ steps.
<b>L5 Step 6 Overlay UFZ and parcels</b>	Positive impact: For each PLSP, calculate the market value of the land and infrastructure that its single implementation would protect	UFZ fc, parcel_address as_val_sqft im_val_sqft	Polygon split/merge OAJ	UFZs joined with OAJ market value (UFZ MV); Create a Map of UFZs symbolized by their appraised value.

<b>L5 Step 7 Compare PLSP and UFZ area &amp; market value</b>	Bring together the outcomes of steps 5 and 6 to assess and compare the relationships among the PLSP and UFZ pairs.	PLSP MV UFZ MV	Join UFZ MV onto PLSP MV using fidtxt and export to new feature class (PLSP MVR); create new fields as needed and calculate the ratio of PLSP/UFZ for their areas and market value	PLSP MVR; Export fidtxt, PLSP areas and market value, UFZ areas and market values and ratios to Excel – create graphs to contrast PLSP and their UFZ. Identify PLSP that can be discarded from consideration and explain your reasoning.
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### Questions and deliverables –

- L5 Step 1 Create LSPs
  - Map of the PLSP labeled by their fidtxt value
- L5 Step 2 create flood zones
  - Map showing at least 4 PLSPs and their associated Flood Zones
- L5 Step 3 Calculate unique flood zone areas
  - A map showing at least 2 PLSPs with dramatically different UFZ areas. Coordinate symbology using the [Import Symbology](#) among the PLSP and UFZ layers using the 'fidtxt' field so the relationship is clearly discernable.
  - Briefly explain the conditions that contributed to the UFZ size difference shown in your map.
- L5 Step 4 Calculate value per square foot
  - Briefly explain why the input value fields are unsuitable for OAJ and why the result of these attribute transformations are.
- L5 Step 5 Overlay PLSP and parcels
  - Map of PLSPs symbolized by their market value
  - Write a brief summary of your OAJ steps.
- L5 Step 6 Overlay UFZ and parcels
  - Map of UFZs symbolized by their market value
- L5 Step 7 Compare PLSP and their UFZ by area & market value
  - Two Excel graphs to contrast PLSP and their UFZ by a) area and b) market values (see Appendix)
  - Discussion: List the PLSPs that can be discarded from future consideration and explain your reasoning.

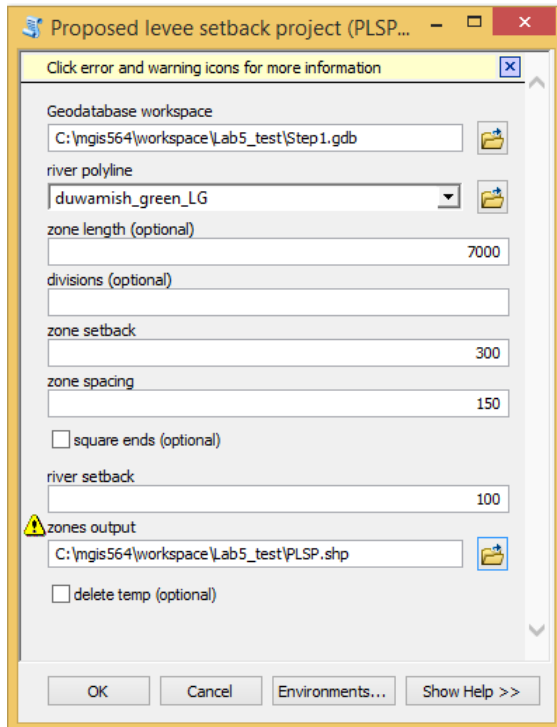
### Expectations and grading –

Performance	Credit	Description
No deliverable	0 points (0%)	No deliverable
Minimal engagement	15 points (60%)	Less than seven steps attempted OR More than three steps demonstrate misunderstanding of course concepts or lack of effort.
Incomplete	20 points (80%)	All seven steps attempted and less than four steps demonstrate misunderstanding of course concepts or lack of effort.

Complete	25 points (100%)	All steps completed demonstrating complete understanding of course concepts
Beyond complete	25 points (100%) with up to five future points	Complete with addition of critique, insight or further exploration of course concepts.

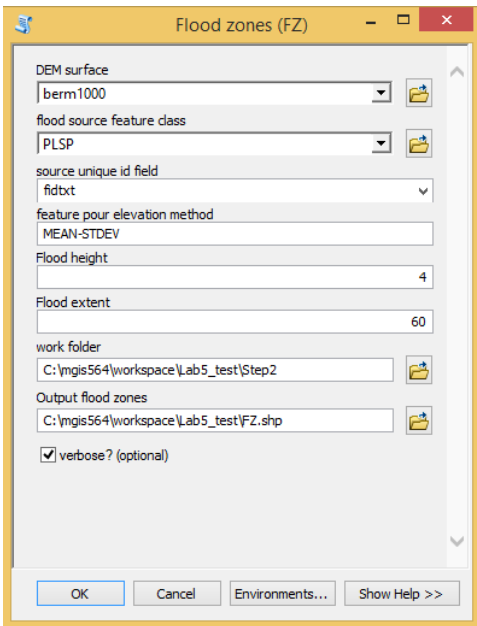
## Appendix – Steps, tool dialogs and insight

### 1. Step 1 - Create PLSPs

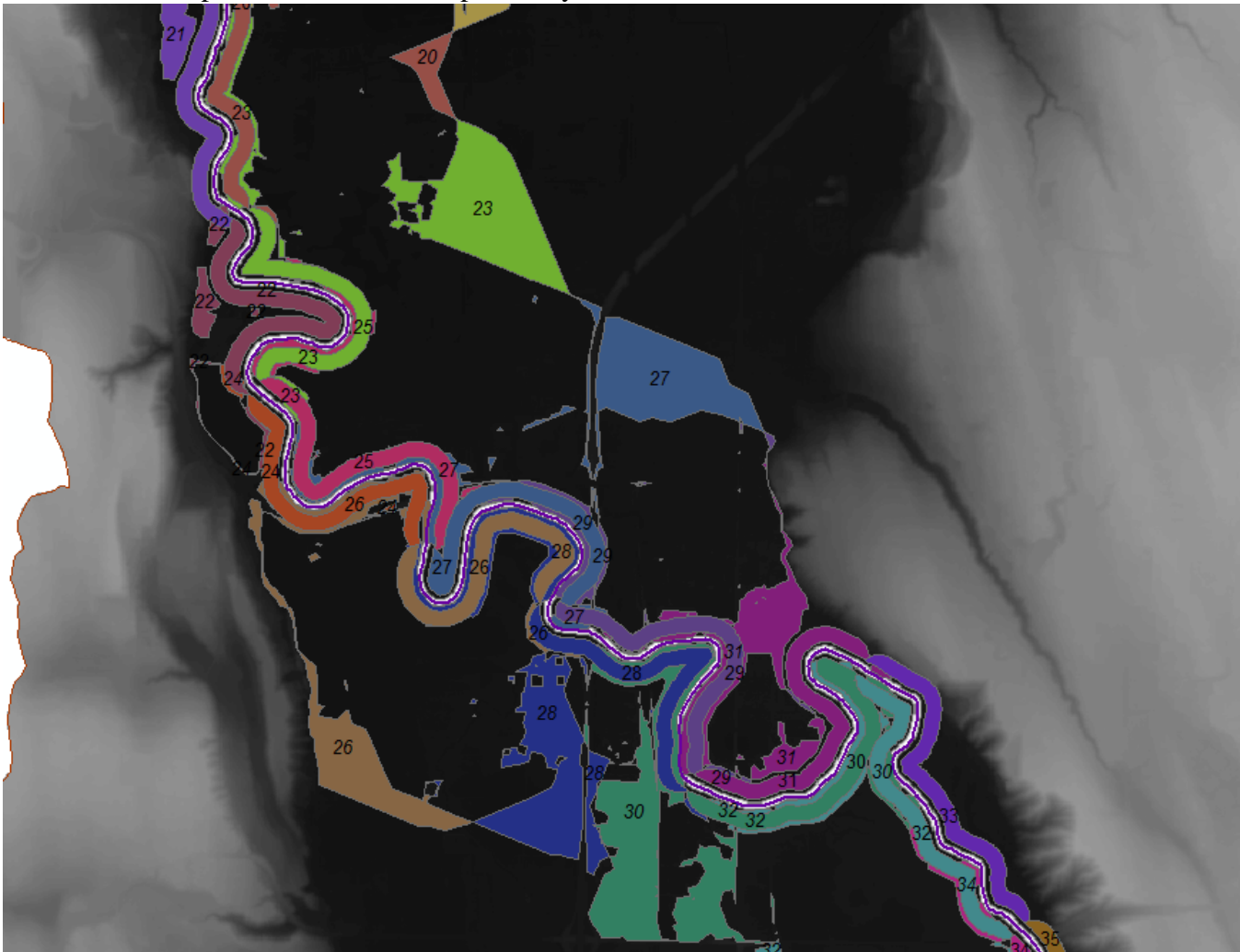


- a.
- b. Note the 'fidtxt' field in the table.
- c. Ungraded thought challenge: The zone spacing sets the amount of space between the zone ends to minimize overlap. Half the setback distance with rounded edges should prevent overlap. Can you find instances where there is overlap in the PLSPs even though the spacing is set to 150? What happens when you use a feature class with overlapping polygons in an overlay operation?

### 2. Step 2 - Create flood zones

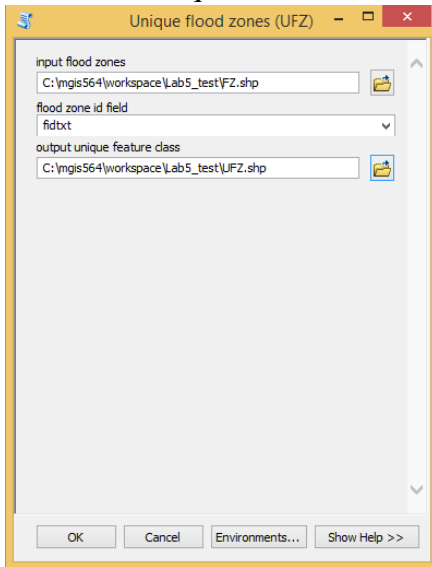


- a.
- b. Note use of 'fidtxt' is used to name the FZs with the id of their source PLSP zones. You can use this field to connect PLSP and FZs when you map them together. You can show the relationship between PLSP and FZ if you symbolize PSLPs as solid fill by fidtxt with a 1pt black outline and [then import that color scheme](#) onto the FZ feature class. Finally, open the 'properties for all symbols' dialog from the FZ symbology dialog and set the outline width to '0'. Now the PLSPs show with a sharp black outline accompanied by their FZs of the same color without an outline.



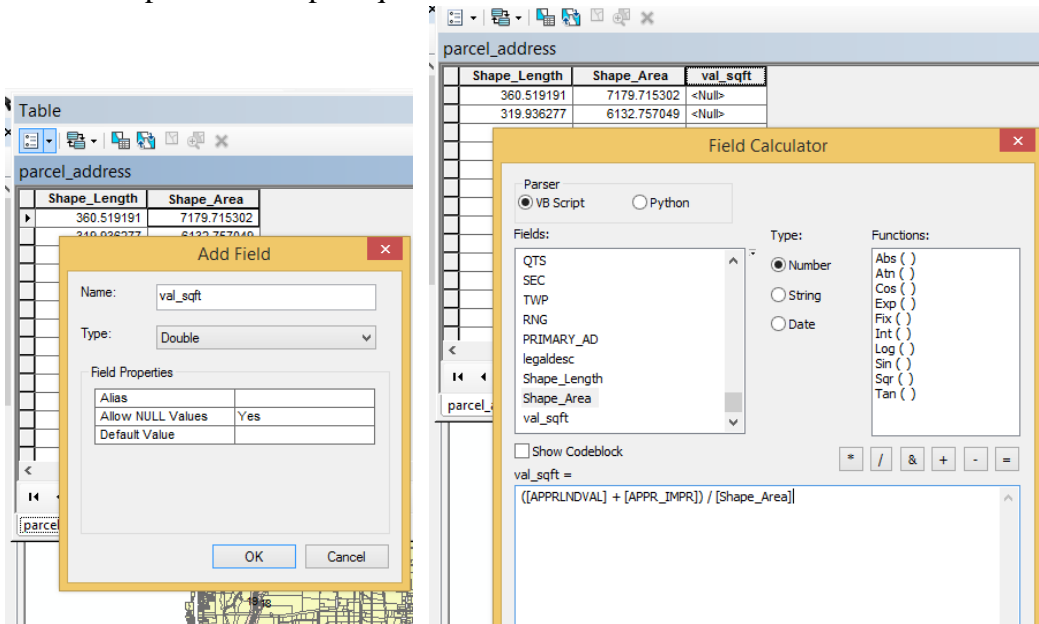
c.

3. Step 3 - Calculate unique flood zone areas



a.

4. Step 4 - Calculate parcel value per sq. foot



a.

5. Step 5 - Overlay PLSP and parcels



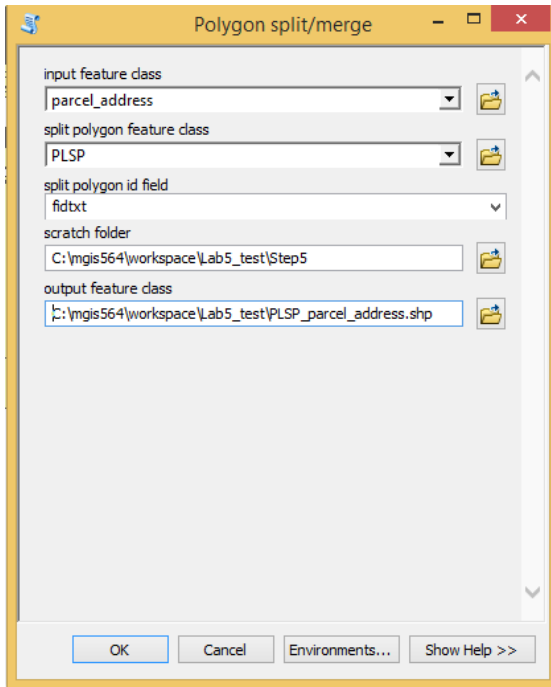
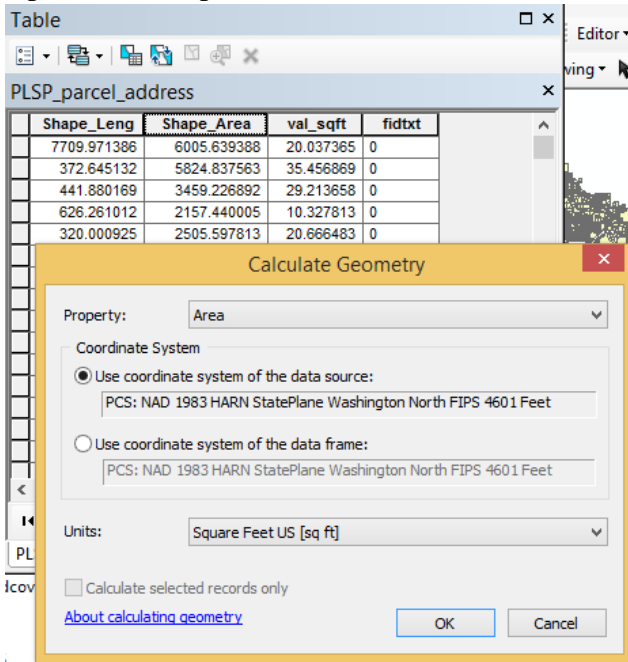


Table			
PLSP_parcel_address			
Shape_Leng	Shape_Area	val_sqft	fidtxt
288.039974	4779.768051	3.138228	1
230.689659	2661.028331	32.318333	1
1546.741477	114543.657007	19.219746	1
1514.39134	13269.263151	0.075362	1
3039.630014	574417.837877	80.075334	1
4777.109527	381103.74886	0	1
549.15082	19959.061221	24.650458	10
2776.122465	360512.721257	29.362625	10
2117.644186	247213.628202	43.380295	10
346.849646	2886.6173	1.732131	10

- 
- Knowing the value per square foot is a step toward deriving the value of each parcel or portion of a parcel in each PLSP footprint. To get market value multiply val\_sqft by the area of the polygons in PLSP\_parcel\_address.
- Update the Shape\_Area field to insure it carries the area of the overlay operation.



- d. Then create a new field type 'double' named 'mktval' and use 'calculate field' to multiply 'Shape\_Area' by 'val\_sqft'.

The screenshot displays the ArcGIS interface. At the top, a table titled 'PLSP\_parcel\_address' is visible with the following data:

Shape_Leng	Shape_Area	val_sqft	fidtxt	mktval
7709.971386	6005.639388	20.037365	0	0
372.645132	5824.837563	35.456889	0	0
441.880169	3459.226892	29.213658	0	0
636.261012	2157.440005	10.327813	0	0

Below the table, the 'Field Calculator' dialog box is open. It is configured with the following settings:

- Parser:  VB Script,  Python
- Type:  Number,  String,  Date
- Fields list: TWP, RNG, PRIMARY\_AD, legaldesc, Shape\_Leng, Shape\_Area, val\_sqft, fidtxt, mktval
- Functions list: Abs (), Atn (), Cos (), Exp (), Fix (), Int (), Log (), Sin (), Sqr (), Tan ()
- Show Codeblock:
- Expression: `mktval = [val_sqft] * [Shape_Area]`

- e. Now use 'Summarize' to add up the market value of all the parcels and parcel pieces in each PLSP footprint.

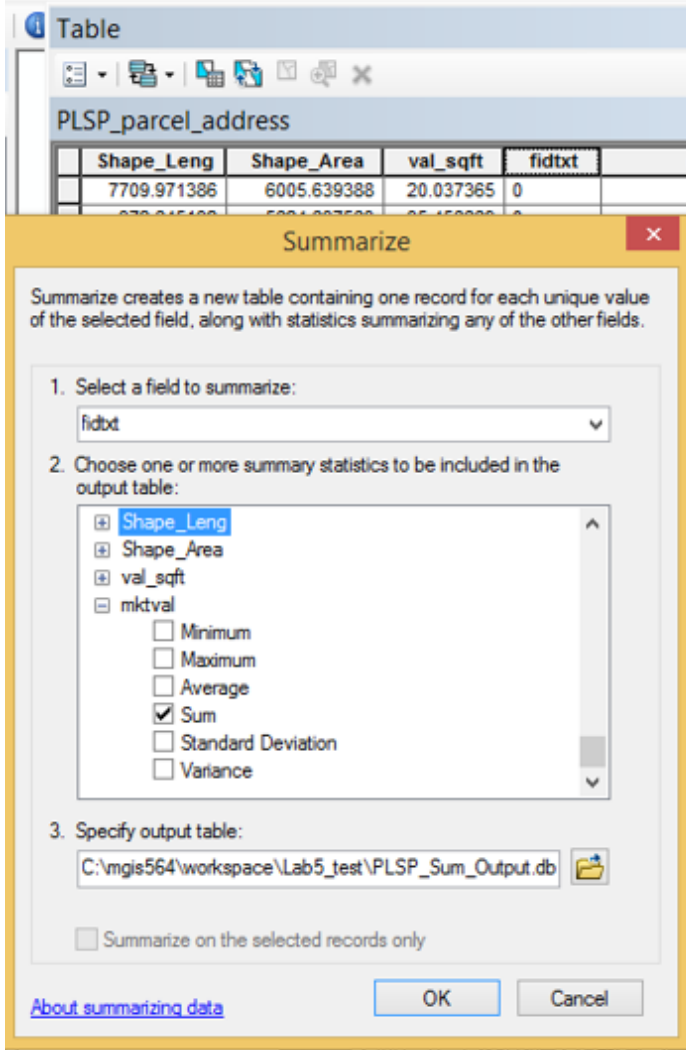
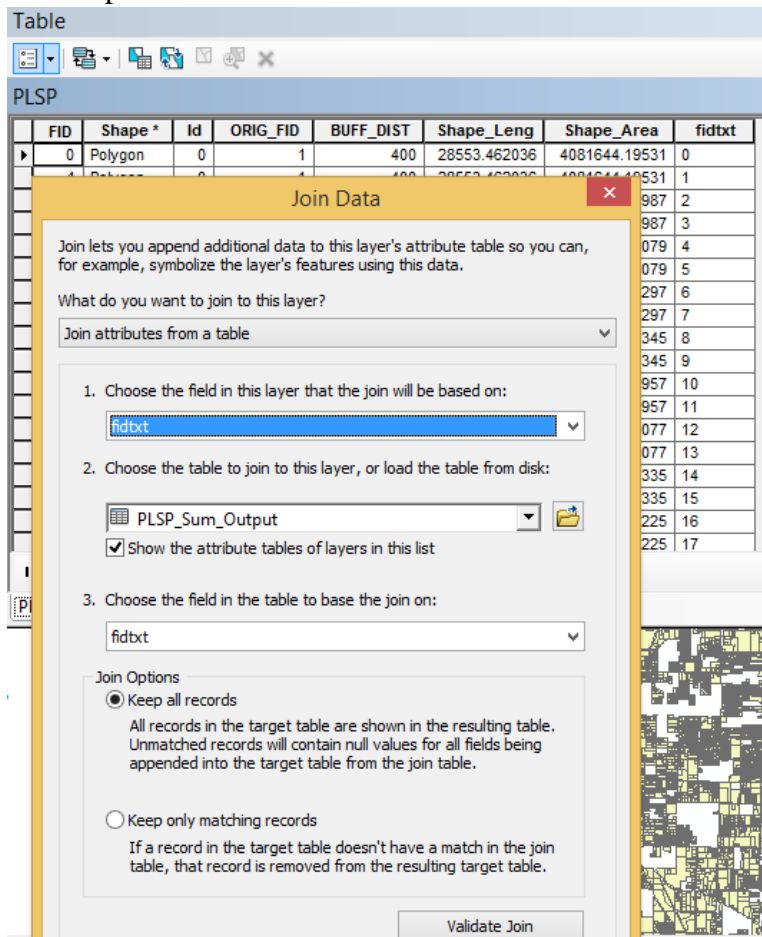
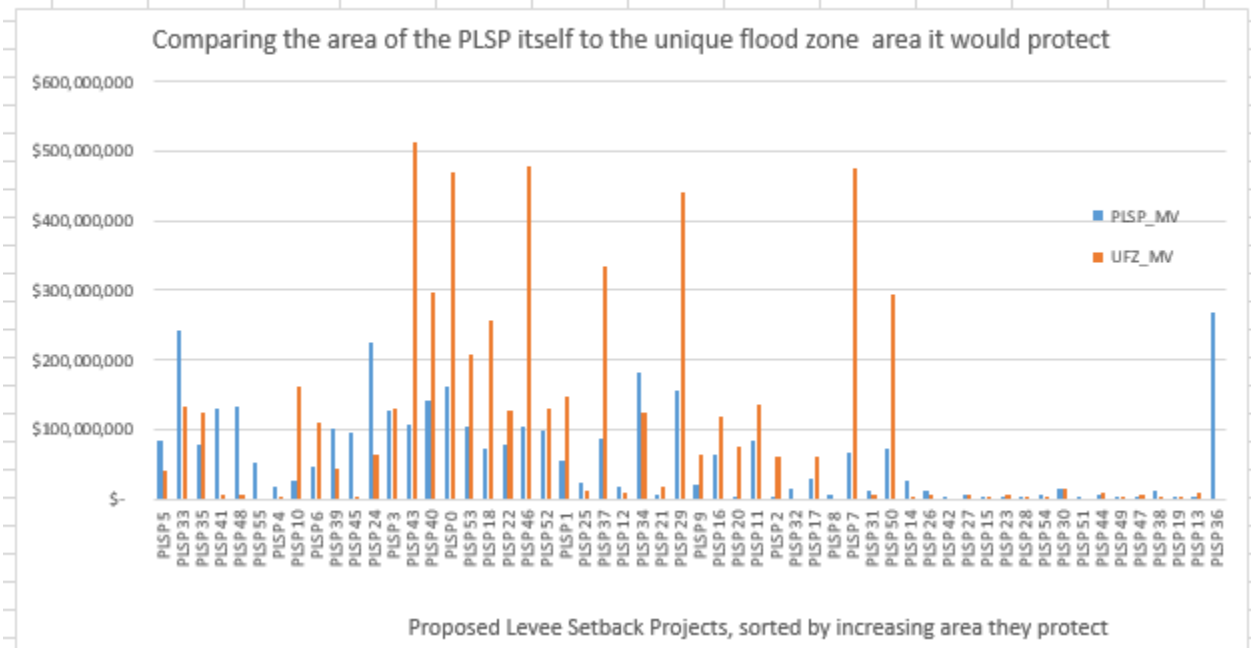
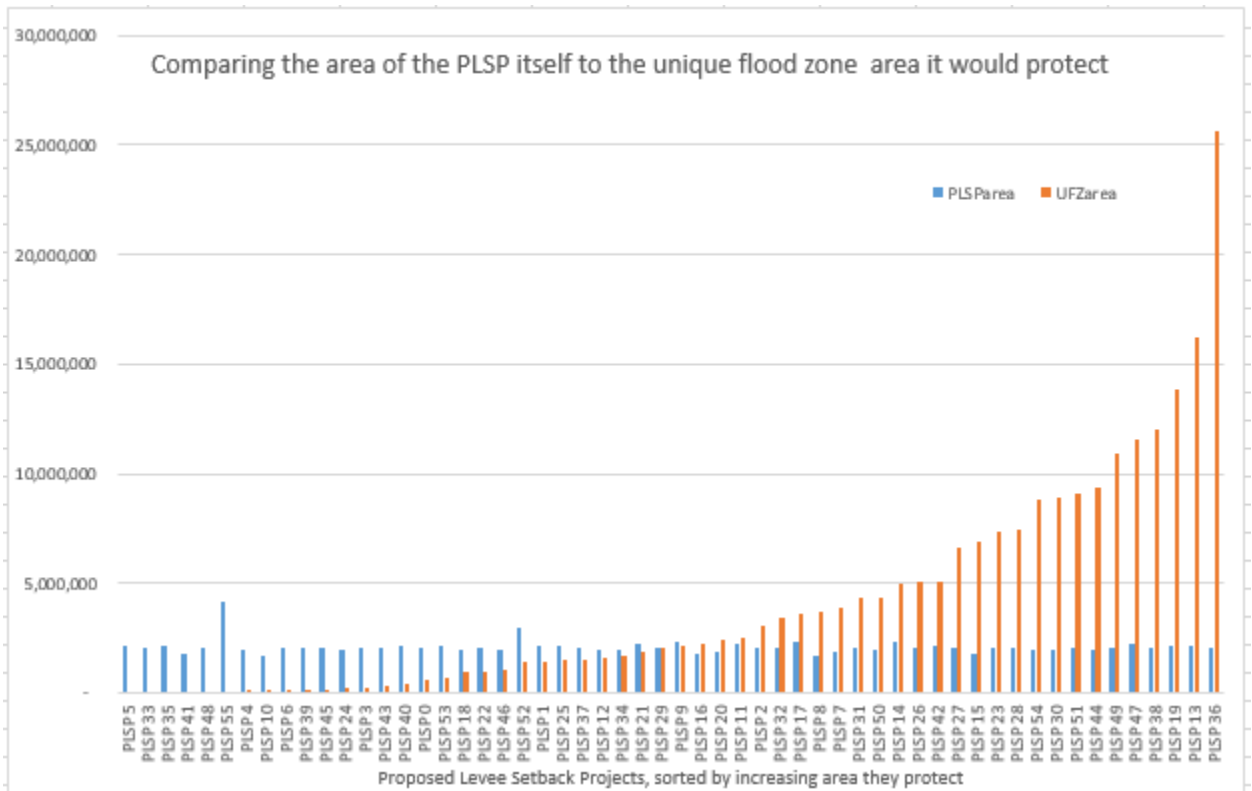


Table				
PLSP_Sum_Output				
	OID	fidtxt	Count_fidtxt	Sum_mktval
▶	0	0	86	23094883.1
	1	1	96	34870296.03
	2	10	24	43172475.26
	3	11	32	38204005.2
	4	12	28	56769824.41
	5	13	29	43657498.19
	6	14	30	40228330.84
	7	15	18	17763203.87
	8	16	23	11002487.18
	9	17	19	15669069.98
	10	18	24	10173973.88
	11	19	25	10370524.43

- f. Last step is to attach the new attribute back to the PSLP feature class where it belongs.



- g. Inspect the result and be sure to export the joined table to commit the join to a single table.
6. Step 6 - Overlay UFZ and parcels
- a. Repeat Step 5 using the UFZ polygons instead of PSLP.
7. Compare PSLP and UFZ area & market value
- a. The actions and deliverables described in the table should be straightforward once you have completed the steps leading up to this final piece. Possible graphs:



b.

Note: This is only one approach to graphing these values, and your values may differ