	<b>WATER RESOURCES DIVISION SURFACE WATER ASSESSMENT SECTION POLICY AND PROCEDURE</b>		DEPARTMENT OF ENVIRONMENTAL QUALITY
Original Effective Date: August 24, 2016  Revised Date:  Reformatted Date:	Subject: Part 323 - Determining Recession Rates of Great Lakes Shorelines		Category: <input checked="" type="checkbox"/> Internal/Administrative <input type="checkbox"/> External/Non-Interpretive <input type="checkbox"/> External/Interpretive
	Program Name: Water Resources Program		Type: <input type="checkbox"/> Policy <input checked="" type="checkbox"/> Procedure <input type="checkbox"/> Policy and Procedure
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*A Department of Environmental Quality (DEQ) Policy and Procedure cannot establish regulatory requirements for parties outside of the DEQ. This document provides direction to DEQ staff regarding the implementation of rules and laws administered by the DEQ. It is merely explanatory; does not affect the rights of or procedures and practices available to the public; and does not have the force and effect of law. DEQ staff shall follow the directions contained in this document.*

**PURPOSE:**

The purpose of the procedure is to establish a standard technical protocol by which Water Resources Division (WRD) staff will identify rapidly eroding shorelines at the county or individual parcel levels by using historic and modern imagery in a geographic information system to determine current recession rates as required by R 281.22. Subrule R 281.22(6) allows a property owner to submit information to the DEQ to review the recession rates on their property. This procedure includes information meant to help guide a property owner in meeting the requirements of R 281.22(6). This procedure is not binding on the property owner; for assistance, refer to [www.mi.gov/shorelands](http://www.mi.gov/shorelands).

**AUTHORITY:**

Part 323, Shorelands Protection and Management, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA).

R 281.22 of the Great Lakes Shorelands Administrative Rules as promulgated pursuant to Part 323 of the NREPA.

**DEFINITIONS:**

“ArcCatalog” is the software used to organize and manage various types of geographic information in a geographic information system.

“ArcMap” is a geospatial processing program used to view, edit, create, and analyze geospatial data.

“Boundary” identifies the point on the shoreline at the end of a high risk erosion area. Parcels on the far side of the boundary are eroding at an annual average of less than one-foot per year.

“Breakpoint” means a point within a high risk erosion area where there is a substantial change in the rate of shoreland recession, typically one-foot or greater.

“Digital Elevation Model (DEM)” is a three-dimensional representation of a terrain’s surface created from elevation data.

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“Digital Shoreline Analysis System (DSAS)” is the software used to draw transects and calculate shoreline recession rates, <http://coast.noaa.gov/digitalcoast/tools/dsas>.

“Earth Resources Data Analysis System (ERDAS) Imagine” is the remote sensing and image analysis software.

“Environmental Systems Research Institute (ESRI)” is the software company that develops geographic information system software.

“Erosion hazard line (EHL)” is identified as the line along the shoreland that is the landward edge of the zone of active erosion or the line where the International Great Lakes Datum (1985) contour for the lake as stated in R 281.21(1)(c) meets the shoreland, whichever is furthest landward. Elevation contour (feet) - Lake Huron 582.9, Lake Michigan 583.7, Lake Superior 604.4.

“Geographic Information System (GIS)” is a computer system that captures, stores, checks, and displays information related to positions on the earth’s surface.

“High Risk Erosion Area (HREA)” means an area of the shoreland where the landward edge of the zone of active erosion has been receding at an average rate of one-foot per year or more, based on a minimum study period of 15 years.

“Metadata” means the data about the imagery - identification (source, flight date, scale, etc.), data quality, spatial data organization, spatial reference, entity and attribute, and distribution and metadata reference information; Differential Global Positioning System (DGPS) data - model of unit used to collect data, accuracy of unit, and differential correction report.

“North American Datum (NAD)” is a formal description of the shape of the earth with an anchor point for the coordinate system.

“Orthorectification” is the process of correcting distortions in image geometry caused by the combined effect of terrain elevation variations and nonvertical angles from the plane or satellite to each point in the image at the time of acquisition.

“Projected Recession Distance (PRD)” is the distance in feet measured landward of the EHL as calculated during the most recent countywide recession rate study or individual parcel study. This distance includes an additional 15 feet to provide protection from severe short-term losses. [R 281.22(2)]

“Quality Assurance (QA)” is an integrated system of policies and procedures to be implemented to ensure an activity is of the type and quality needed to accomplish a goal.

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“Quality Control (QC)” is the overall system of technical activities that measure the attributes and performance of a process against defined standards.

“Root mean squared error (RMS)” is a measure of the differences between values predicted by a model and the values actually observed. The RMS is an indicator of how well the selected imagery overlaid a source image.

“Transect” is a straight line, perpendicular to the shoreline, along which measurements are recorded.

“Zone of active erosion” means the area of the shoreland where the disturbance or loss of soil and substrate has occurred with sufficient frequency to cause unstable slopes or prevent vegetation of the area. [R 281.21(1)(r)]

**PROCEDURES:**

Step	Who	Does What
1	County study - WRD Staff  Individual parcel study R 281.22(6) - Owner/Agent	<b>Identifies study area and processes imagery needed for the study following steps 1 a through 1 e. Once completed, goes to step 2. Uses the checklist in Appendix 1 to track progress.</b>
1 a	County study - WRD Staff  Individual parcel study R 281.22(6) - Owner/Agent	<p><u>Identifies study area.</u> - The study area will include all previously studied shoreline. Views oblique imagery to identify other areas at risk and reviews the United States Army Corps of Engineers (USACE) geodatabase to identify bluff areas. Contacts the county or township zoning administrator to learn of specific areas that may need study in their municipality. Areas not typically included are coastal wetland, cobble shores, and armored shorelines without bluffs behind them.</p> <p>For individual parcel studies, the parcel owner's agent provides written authorization from the parcel owner to conduct the study. The study area is identified by county, municipality, township, range, section, address, parcel number, and legal description.</p>

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Step	Who	Does What
1 b	<p>County study - WRD Staff</p> <p>Individual parcel study R 281.22(6) - Owner/Agent</p>	<p><u>Identifies historic photosets or imagery.</u> - The best available imagery will be selected from the WRD aerial imagery archives or comparable sources, Appendix 2. Imagery attributes are assessed to determine the best historic year to use in the study. Those attributes include scale, time of year the photo was taken - leaves off the trees (leaf-off) or leaves on the trees (leaf-on), image quality, format, water level at time of photo, and shoreline coverage. Additional considerations include choosing the longest time period between the historic and modern photosets to account for the widest possible range of water levels and shoreline fluctuations contributing to the current location of the shoreline. The minimum study period is 15 years, R 281.22(1). Records metadata.</p> <p>When choosing the historic imagery, there may need to be several years chosen in order to cover the shoreline in the study area. For historic photos, the scale should be no smaller than 1:12,480; the best scale is 1:6000 or less. Notes the water level at the time the photos were taken. Chooses historic photoset of similar water level to the current with the interim years covering a wide range of water levels. Looks for the highest quality photos with good exposure, contrast, and leaf-off.</p> <p>Determines if a harbor or other shoreline structure has significantly altered the longshore process of sediment movement resulting in accretion on one side of the harbor and sediment starvation on the other side. This has the potential to skew recession/accretion rates. For existing harbor structures, identifies the year of construction. Assesses available photos taken before and after construction of the harbor structures. Uses the photos taken postharbor construction if the geomorphology of the shore in postconstruction times significantly differs from those taken prestructure.</p> <p>Ensures there are photo-identifiable ground features that will provide quality locations for DGPS data collection if needed.</p> <p>For individual parcel studies, the owner may choose to submit a Freedom of Information Act (FOIA) request to the DEQ for available imagery or search comparable resources, Appendix 2, using the same criteria. The DEQ recommends the owner contact the WRD to concur on the selected historic imagery.</p>

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Step	Who	Does What
1 c	County study - WRD Staff  Individual parcel study R 281.22(6) - Owner/Agent	<p><u>Identifies modern imagery.</u> - For countywide studies, chooses the most recent imagery with a resolution of one-foot or less, and leaf-off. Records metadata.</p> <p>For individual parcel studies, the owner or their agent will be collecting current erosion hazard line data using DGPS to add to a historic aerial image.</p>
1 d	County study - WRD Staff  Individual parcel study R 281.22(6) - Owner/Agent	<p><u>Scans imagery.</u> - Aerial imagery is scanned as gray scale images. Most historic photographs will have an acquisition scale of 1:6000 or less. Scan photos at a resolution of 1,000 dots per inch. This imagery will have a resolution of one-foot or less. When constructing orthophotos, it is necessary to scan the entire photograph including all fiducial marks; however, photos may need to be cropped to remove excess open water and/or forested upland to better process the image.</p> <p>The naming convention for digital image files is: county folder, year folder, [Photo Month, Day, Year]_[Flight line #-Photo#]. Images will be scanned as Tagged Image File Format (TIFF) files initially; however, these are imported to .img format for the images being used within ERDAS Imagine where there are better controls for contrast. Creates pyramid layers for these images as this will allow faster viewing, zooming, and panning when using this imagery.</p>

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Step	Who	Does What
1 e	<p>County study - WRD Staff</p> <p>Individual parcel study R 281.22(6) - Owner/Agent</p>	<p><u>Orthorectifies the scanned imagery.</u></p> <p><u>Selection of a DEM</u> During orthorectification, DEMs provide the vertical reference information. When a Ground Control Point (GCP) is selected, the z value (elevation) is automatically read from the DEM. The units for elevation in a DEM are typically feet, but the units may vary depending on the type of the DEM that is being used. Makes sure the vertical units are properly set.</p> <p>High resolution DEMs are the preferred vertical reference data source. The DEM with the highest resolution is a Light Detection and Ranging (LiDAR) survey. Currently the best place to search for LiDAR DEM data sets is the National Oceanic and Atmospheric Administration's, Coastal Services Center, Appendix 2. If a high resolution LiDAR data set is not available, a 10-meter or 30-meter National Elevation Dataset DEM are the next best data sources, Appendix 2.</p> <p>The orthorectification process requires the following steps:</p> <ol style="list-style-type: none"> <li>a) Load the historic image into ERDAS Imagine.</li> <li>b) Select the control points tool.</li> <li>c) Select the model selection tool.</li> <li>d) Select the projective transform model.</li> <li>e) Select the reference image, this is the modern image with a resolution of one-foot or better.</li> <li>f) Select the DEM chosen earlier as your elevation source.</li> <li>g) Select GCPs. A minimum of six points for this model is required; the WRD finds a minimum of ten GCPs per image selectively spread throughout the image.</li> <li>h) After six points are achieved, the software will attempt to auto match points chosen. You can move these points to match if they do not match during the auto match process.</li> <li>i) Make sure when these points are chosen that the Z Ref. value is displayed in feet.</li> <li>j) Note the RMS error. If the RMS error is above one, the point is not matching accurately.</li> </ol>

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1 e cont.		<ul style="list-style-type: none"> <li>k) After all points have been chosen you can rectify the image; add the .rec to the end of the photo naming convention to identify the processed image.</li> <li>l) The processed image is loaded into ArcMap and overlaid on the current image to check the quality of the rectification process.</li> <li>m) Save the reports RMS values generated for each image. The RMS will be used in step 3 b.</li> <li>n) The RMS error will measure the transformation error of the orthorectification process for the selected imagery by determining the distance between the location of a GCP on the source imagery and the image being rectified. This error will be translated to feet for each image being rectified and provide a measure of the relative accuracy of the location of the EHLs. Every effort will be made to minimize the RMS error during the orthorectification process.</li> <li>o) During the orthorectification process, the acceptable error will be one-foot or less.</li> </ul>
2	County study - WRD Staff  Individual parcel study R 281.22(6) - Owner/Agent	<p><b>Identifies the erosion hazard line following steps 2 a through 2 e. Once completed go to step 3.</b> - The recession rate study compares the EHL of the shoreline on historical aerial photographs to the EHL on modern aerial photographs. The EHL, as defined in R 281.21(c), means the line along the shoreland that is the landward edge of the zone of active erosion or the line where the 604.4 feet International Great Lakes Datum (IGLD) 1985 contour on Lake Superior, 582.9 feet on Lake Huron, and 583.7 feet on Lake Michigan meets the shoreland, whichever is furthest landward. The zone of active erosion means the area of the shoreland where the disturbance or loss of soil and substrate has occurred with sufficient frequency to cause unstable slopes or prevent vegetation of the area, R 281.21(r).</p>

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2 a	County study - WRD Staff  Individual parcel study R 281.22(6) - Owner/Agent	<p><u>Identifies the historic EHL.</u> - To identify the underlying trend in shoreline change, the EHL is hand digitized on the processed historical imagery. The EHL is digitized between representative fractions/map scales of ~1:500 to 1:1,000. The EHL is determined by viewing the vegetation lines and shadows of bluffs along the shoreline. Every effort is made to eliminate noise that may be introduced by digitizing around every tree or bump. When ravines are encountered, the EHL is drawn across the top of the ravine. The EHL does not travel up the ravine. If there is an eroding feature behind an armored shoreline, the landward edge of the feature is determined to be the EHL. If there is no eroding feature behind an armored shoreline, the top of the armor is determined to be the EHL.</p>
2 b	County study - WRD Staff  Individual parcel study R 281.22(6) - Owner/Agent	<p><u>Identifies the modern EHL.</u> - For countywide recession studies, the modern EHL is determined using the same method as with the historic imagery with the added information provided by the 2012 USACE Great Lakes Oblique Imagery that shows the shoreline from an offshore vantage point. An additional resource is the USACE Great Lakes Shoreline Geodatabase that gives the approximate location of areas of various bluff heights among other attributes. Cross-referencing these resources with the modern imagery is helpful in determining the modern EHL. The EHL is determined for all previously designated HREAs and areas of apparent erosion.</p> <p>For an individual parcel study, the current EHL is identified on-site, photographed, and dated as noted in step 2 c.</p>



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Step	Who	Does What
2 c	<p>County study - WRD Staff</p> <p>Individual parcel study R 281.22(6) - Owner/Agent</p>	<p><u>Collects Global Positioning System (GPS) data.</u> - For countywide recession studies, a submeter DGPS accurate to one-foot or less, will be used to collect data as needed to verify locations of current EHLs.</p> <p>For individual parcel studies, the current EHL is identified as the line along the shoreland that is the landward edge of the zone of active erosion, R 281.21(1)(c). The zone of active erosion means the area of the shoreland where the disturbance or loss of soil and substrate has occurred with sufficient frequency to cause unstable slopes or prevent vegetation of the area, R 281.21(1)(r).</p> <p>Subrule R 281.22(2) requires the DEQ to designate properties as HREAs if the long-term rate of erosion is at least one-foot per year. The DEQ needs to be able to accurately locate the EHL in order to calculate the long-term average erosion rate. In order to achieve this level of accuracy, the WRD strongly recommends the use of a DGPS with submeter accuracy to document the location of the property boundaries and the EHL. DGPS data can be collected either in "node" (i.e., point collection) or "streaming" (continuous data collection) modes. If DGPS data is collected in "node" mode, then the WRD recommends that DGPS data be collected at the property boundaries and at the furthest landward location of the EHL. If the node points are located more than 150 feet apart, the WRD recommends collecting additional node points, evenly spaced, no more than 150 feet apart. Once collected, DGPS data is processed and a differential correction report is generated.</p> <p>In order to allow the WRD to locate the EHL, property lines, and DGPS data collection locations at a later date, the WRD recommends that these locations be clearly identified on the ground using survey flags or painted stakes. Photographs of the shoreline, bluff, DGPS locations, and the EHL are very helpful.</p>

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Step	Who	Does What
2 d	County study - WRD Staff  Individual parcel study R 281.22(6) - Owner/Agent	<u>Conducts QA and QC.</u> - Staff will review the location of the digitized line with the aid of oblique photos, available field data, and in conference with knowledgeable staff. Problem areas will be discussed and decisions made as to how to proceed.  For individual parcel studies, the GPS data is corrected and the differentiation correction report submitted to the WRD as recommended in step 2 e.
2 e	Individual parcel study R 281.22(6) - Owner/Agent	<u>Submits data to WRD.</u> To meet the requirements of R 281.22(6), the following information is recommended.  <ol style="list-style-type: none"> <li>1) Digital imagery in Tiff, Geo-Tiff, or .img format projected to Michigan Georef, Meters, NAD 83.</li> <li>2) The historic image metadata from step 1 b and metadata of any other submitted imagery.</li> <li>3) The metadata of the DEM from step 1 e.</li> <li>4) The RMS error table created with the orthorectified imagery from step 1 e.</li> <li>5) The differential correction report generated when correcting the GPS data in step 2 c.</li> <li>6) Photographs of the site taken in step 2 c.</li> <li>7) An accurately rectified historic, low-altitude, vertical aerial image showing the DGPS collected data of the current EHL as an ESRI shapefile or feature class data format for use in ArcMap with the shoreline analysis software.</li> </ol>
2 f	WRD Staff	<u>Reviews individual parcel owner request under R 281.22(6).</u> Reviews request for completeness. If incomplete, sends letter requesting the information to make the request complete. If the request is complete, the WRD has 60 days to make a decision. Field verifies the EHL.

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Step	Who	Does What
3	WRD Staff	<p><b>Conducts the shoreline analysis by following steps 3 a through 3 b. Once completed go to step 4.</b> - The recession rate calculation is made using GIS software. ArcMap with the extension DSAS has an automated recession rate calculation tool.</p> <p>All DSAS input data will be managed within a personal geodatabase, which also serves as the storage location for the program-generated transect feature class and related statistical output tables. Preexisting data, such as shapefiles, can be imported as feature classes within a geodatabase in ArcCatalog. The DSAS requires that data be in meter units in a projected coordinate system. The WRD uses Michigan Georef, Meters, NAD 83.</p>
3 a	WRD Staff	<p><u>Identifies transect spacing.</u> When conducting a countywide study, transects will be drawn perpendicular to the shoreline and spaced at 150-foot intervals in DSAS. The standard of 150-foot spacing for transects was required by the Federal Emergency Management Agency during the studies conducted by the department in the late 1990s and will be retained for future studies.</p> <p>For individual parcel studies, WRD staff will locate transects using DSAS as follows:</p> <ol style="list-style-type: none"> <li>a. One transect on each parcel line.</li> <li>b. One transect at the furthest landward edge of active erosion.</li> <li>c. A minimum of two additional transects evenly spaced, maximum spacing 150 feet, between the parcel lines.</li> </ol>

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Step	Who	Does What
3 b	WRD Staff	<p>Calculates rates and error. - The studies use an end-point analysis to compare two EHLs. Rates are calculated by dividing the distance of shoreline movement by the time elapsed between the oldest and the most recent EHL.</p> <p>The overall data quality objective is the calculation of reliable annualized recession rates with error bars of plus or minus 0.5 feet per year or less. Errors in the calculation of the recession rates result from image orthorectification, digitization of the EHL, and poor image resolution. The error associated with image orthorectification is measured by the RMS error during processing. The digitization of the EHL is checked by multiple staff during quality assurance and quality control and compared to DGPS data collected in the field. The image resolution is held to one foot or less for historic and modern imagery. The resolution of historic imagery meets this criterion when historic photographs are scanned at 1,000 dots per inch.</p> <p>To determine the error surrounding a calculated rate of uncertainties (uncy), identified as orthorectification RMS error for the images used in the end point rate calculations, are each squared, then added together (summation of squares). The square root of the summations of squares is divided by the number of years between the two EHLs. The result of this calculation is reported as the confidence of the end point rate calculation (ECI), plus or minus feet per year.</p> $ECI = \frac{\sqrt{(\text{uncy } A)^2 + (\text{uncy } B)^2}}{\text{year } B - \text{year } A}$ <p>where uncy A = RMS error from the orthorectification of the historic imagery, uncy B = RMS error from the orthorectification of the modern imagery if calculated, year A = year of historic EHL, year B = year of modern EHL (DSAS 4.0 2009, Hapke et al., 2010).</p> <p>For individual parcel studies, WRD staff will review the RMS report generated during orthorectification in step 1 e and recommended for submittal in step 2 e.</p>

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Step	Who	Does What
4	WRD Staff	<b>Determines the locations of high risk erosion areas by following steps 4 a through 4 c. Once completed go to step 5.</b>
4 a	WRD Staff	<u>Identifies locations of receding shorelines.</u> - Similar rates are grouped into HREAs. An HREA exists wherever there are at least three consecutive transects, each showing recession of one-foot or greater per year. When identifying areas of recession, the lowest rate is determined to be 0.95-foot per year rounded to one-foot per year (Appendix 3). The HREA continues in each direction until two consecutive transects show recession to be less than one-foot per year. The end boundaries of the HREA are located at the parcel lines adjacent to the last transects having a recession rate equal to or greater than one-foot per year.
4 b	WRD Staff	<p><u>Identifies breakpoints.</u> - The recession rate of each transect within an HREA contributes to the average recession rate for the HREA, R 281.22(2). Recession rates within an HREA can vary widely and further grouping of the rates within the HREA may be needed to provide an average rate that better represents a specific reach of shoreline.</p> <p>Within an HREA, the breakpoints between dissimilar recession rates are determined and verified using descriptive statistics (mean, standard deviation, coefficient of variation, and 95 percent confidence interval). Transect rates that are within approximately one-foot, plus or minus, of the mean of the rates are grouped together. Verifies the proposed grouping by calculating the mean, minimum, and maximum values. Verifies the breakpoints within an area by calculating the mean and standard deviation of each grouping. Determines the normality of the data by calculating the coefficient of variation (CV) or standard deviation/average. The CV should be less than one to characterize a dataset with a normal distribution. As the data are typically normally distributed, calculate the upper and lower 95 percent confidence interval (CI) for each grouping and graph. Adjacent groupings that do not have overlapping confidence intervals are significantly different. See the example in Appendix 4. If adjacent average recession rates are similar, the position of the breakpoint is reassessed. New averages are calculated for groups of transects within the area on either side of the breakpoint. For data that are not normally distributed, consult a statistician.</p>

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Step	Who	Does What
4 c	WRD Staff	Calculates PRDs. - Average recession rates are calculated and PRDs are determined for each grouping of transects within an area. The 30-year PRD is equal to (recession rate feet per year * 30), rounded to the nearest value divisible by 5, plus 15 feet to provide protection from severe short-term erosion losses, R 281.22(2). The 60-year PRD is calculated in the same manner. Appendix 5 shows common recession rates with the 30- and 60-year PRDs.
5	WRD Staff	<b>Identifies affected parcels by following steps 5 a through 5 f. Once completed go to step 6.</b>
5 a	WRD Staff	<u>Develops a digital parcel layer.</u> - Identifies the extent of shoreline for which parcel data is required. Include the shorelines where parcels are currently designated and will be designated.  Contacts the county equalization office to request and receive parcel boundaries in digital format, parcel identification numbers and physical addresses and current parcel owner mailing addresses for the identified shorelines.  Constructs the parcel layer of the shoreline areas of past and current recession. Some digitizing may be necessary depending on the format of the information received from the county.
5 b	WRD Staff	<u>Identifies parcels for a designation action.</u> - View parcel layer, historic rate layer, and current rate layer in GIS.  Creates a 60-year PRD line layer measured from the modern EHL. All parcels within the 60-year PRD will have a designation action. When there are multiple small parcels landward of the shoreline parcel, looks at parcel dimensions to determine if the landward parcels are regulated.
5 c	WRD Staff	<u>Assigns sequence numbers to each parcel.</u> - Sequence numbers are assigned to parcels from north to south or east to west in ascending order. If the 60 year PRD line extends onto inland tiers of parcels, follow the numbering method found in Appendix 6. Within a township, when there is a break in the HREA, stop the numbering and resume with next HREA in the same township. Each township begins with sequence number one.

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5 d	WRD Staff	<p><u>Determines the status of the affected parcels.</u> - Status is the result of comparing the PRDs of the same parcels and shorelines over time.</p> <p>The status codes are as follows:            N - new designation            IS - increase in PRD due to increase in the rate of recession,            S - no change in PRD            L - PRD is lowered            D - parcel is de-designated (no longer in an HREA)            ND - an appeal after designation resulting in a parcel not being designated</p> <p>Data management:</p> <ol style="list-style-type: none"> <li>1) From the master HREA database of all parcel numbers, create a working table of all records for the county or township. To the working table, add the records of the parcel layer with the PRDs created for the update study.</li> <li>2) Sort by parcel number.</li> <li>3) Determine status by comparing parcel numbers and PRDs across study years.               <ol style="list-style-type: none"> <li>a) Look across all studies at PRDs and determine whether any parcels become substandard as defined in R 281.21(1)(o).</li> <li>b) Use available resources to aid in status determination. See the county equalization parcel search page for previously designated parcels that have since been combined or split. Designations run with the land, so it's important to identify all splits.</li> <li>c) Concurrently use the aerial photo and parcel boundary data layers to ensure the correct parcel is being designated.</li> </ol> </li> <li>4) To track the regulatory authority over parcels [R 281.21(1)(o)] record splits and combinations into the PIN History table of the High_Risk_Erosion_Statewide_Data database.</li> </ol>

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Step	Who	Does What
5 e	WRD Staff	<u>Updates currently designated parcels.</u> - Uses the county table created in step 5 d for mailings. Makes all edits to this table before appending to statewide table.
5 f	WRD Staff	<u>Compiles study statistics, findings, and maps.</u> - Determines miles of shoreline studied, affected, and changes to HREAs. Writes study report. Creates maps.
6	WRD Staff	<b>Notifies parcel owners and local officials, R 281.22(1), by following steps 6 a through 6 i. Once completed, goes to step 7.</b>
6 a	WRD Staff	<u>Contacts the Office of Environmental Assistance</u> to reserve a date to record a webinar. A webinar gives interested persons the convenience of viewing the same information that will be presented at a public meeting.
6 b	WRD Staff	<u>Sets public meeting date, time and location.</u> - Meetings are held in the county, one in the evening for the public and one during the day for the local officials.
6 c	WRD Staff	<u>Notifies parcel owners and officials.</u> - Sends letters to parcel owners and officials, R 281.22(1).
6 d	WRD Staff	<u>Advertises webinar and public meeting</u> in the DEQ Calendar and posts on the shorelands Web site. Posts preliminary maps and findings to Web site. The maps will be in pdf format and may be zoomed in for clarification by the viewer.
6 e	WRD Staff	<u>Develops presentation for webinar and public meetings.</u>
6 f	WRD Staff	<u>Posts recorded webinar on Web site.</u>
6 g	WRD Staff	<u>Conducts meetings with public and local government officials.</u>
6 h	WRD Staff	<u>Responds to public comments.</u> Conducts site visits as needed when responding to specific parcel owner concerns.
6 i	WRD Staff	<u>Creates final maps in ArcMap and writes report.</u>
7	WRD Staff	<b>Proceeds with designation process by following steps 7 a through 7 h.</b>



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Step	Who	Does What
7 a	WRD Staff	<u>Writes briefing for division management review.</u> The authority for notification of the designation, modification, or removal of properties from an HREA is delegated to the division chief or assistant division chief. This briefing requires their review and signature before certified letters are mailed.
7 b	WRD Staff	<u>Creates lists of regulated parcel identification numbers for zoning administrators in county.</u>
7 c	WRD Staff	<u>Sends designation letters by certified mail to parcel owners and government officials, R 281.22(3).</u> Includes with the zoning administrator letters the lists of regulated parcel identification numbers. These letters establish the changes proposed in the earlier mailing. Following this mailing, parcel owners whose properties are newly designated, or the PRDs have increased, have up to 60 days to submit formal appeals of the WRD's actions. R 281.22(20)
7 d	WRD Staff	<u>Responds to appeals received during the 60-day appeal period.</u> Staff will review the parcel owner's concerns, conduct a site visit if necessary, and make adjustments if appropriate or proceed with an administrative contested case hearing.
7 e	WRD Staff	<u>Posts final maps and report to Web site.</u>
7 f	WRD Staff	<u>Sends updated lists of regulated parcels to local officials.</u>
7 g	WRD Staff	<u>Creates and sends shapefiles upon request.</u>
7 h	WRD Staff	<u>Appends new data to HREA statewide database.</u> Appends the county table to the HREA_Database_All_Parcel table in the High_Risk Erosion_Statewide_Data database after all appeals have been resolved.

**REFERENCES:**

Hapke, C.J., Himmelstoss, E.A., Kratzmann, M., List, J.H., and Thieler, E.R., 2010, National assessment of shoreline change: Historical shoreline change along the New England and Mid-Atlantic coasts: U. S. Geological Survey Open-File Report 2010-1118, 57 p.

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Himmelstoss, E.A. 2009. "DSAS 4.0 Installation Instructions and User Guide" in Thieler, E.R., Himmelstoss, E.A., Zichichi, J.L., and Ergul, Ayhan. 2009 Digital Shoreline Analysis System (DSAS) version 4.0 - An ArcGIS extension for calculating shoreline change: U.S. Geological Survey Open-File Report 2008-1278. \*updated for version 4.3.

**APPENDICES:**

- Appendix 1. Checklist for recession rate study.
- Appendix 2. List of imagery sources.
- Appendix 3. Significant Figures, WRD Policy and Procedure.
- Appendix 4. Sample table and graph of descriptive statistics of groups.
- Appendix 5. Recession rates and projected recession distances.
- Appendix 6. Sequence numbering of regulated parcels.

SECTION CHIEF APPROVAL:

 8/24/16  
Robert Day, Acting Chief  
Surface Water Assessment Section

Appendix 1. Checklist for recession rate study.


Part 323 - Recession Rate Study, R 281.22 Study Area and Date:

	Step		Substep	County Study	Individual Property Study R 281.22(6)
1	Identify study area and process imagery	a	Identify study area	WRD Staff	Owner/Agent
		b	Identify historic imagery	WRD Staff	Owner/Agent
		c	Identify modern imagery	WRD Staff	Owner/Agent
		d	Scan imagery	WRD Staff	Owner/Agent
		e	Orthorectification of imagery	WRD Staff	Owner/Agent
2	Identify erosion hazard line	a	Identify the historic EHL	WRD Staff	Owner/Agent
		b	Identify the modern EHL	WRD Staff	Owner/Agent
		c	Collect GPS data	WRD Staff	Owner/Agent
		d	Conduct QA and QC	WRD Staff	Owner/Agent
		e	Submit data to WRD in digital format	na	Owner/Agent
		f	Review individual property owner's request	na	WRD Staff
3	Shoreline analysis	a	Identify transect spacing	WRD Staff	WRD Staff
		b	Calculate rates and error	WRD Staff	WRD Staff
4	Determine high risk erosion areas	a	Identify locations of receding shorelines	WRD Staff	WRD Staff
		b	Identify breakpoints	WRD Staff	WRD Staff
		c	Calculate projected recession distances	WRD Staff	WRD Staff
5	Identify affected parcels	a	Develop a digital parcel layer	WRD Staff	WRD Staff
		b	Identify parcels for a designation action	WRD Staff	WRD Staff
		c	Assign sequence numbers to parcels	WRD Staff	WRD Staff
		d	Determine status of affected parcels	WRD Staff	WRD Staff
		e	Update currently designated parcels	WRD Staff	WRD Staff
		f	Compile study statistics, findings, and maps	WRD Staff	WRD Staff

Appendix 2. List of imagery sources.

- DEQ-WRD Aerial Imagery Archives.
- Michigan State University (MSU) Aerial Imagery Archives held with the Remote Sensing and Geographic Information Systems in the MSU Geography Department at [http://www.rsgis.msu.edu/aerial\\_archive/index.php](http://www.rsgis.msu.edu/aerial_archive/index.php)
- National Oceanic and Atmospheric Administration's, Coastal Services Center online data portal called the "Digital Coast": <http://www.csc.noaa.gov/digitalcoast/data/index.html>.
- DEMs are available through the United States Geological Survey (USGS) at <http://nationalmap.gov/elevation.html>.

Appendix 3. Significant Figures, WRD Policy and Procedure.

 <b>WATER BUREAU POLICY AND PROCEDURES</b>	
<b>NUMBER:</b>	<b>WB - 015</b>
<b>SUBJECT:</b>	<b>SIGNIFICANT FIGURES</b>
<b>EFFECTIVE DATE:</b>	<b>FEBRUARY 8, 2008</b>
<b>REVISION DATE:</b>	<b>(5-YEAR REVIEW FREQUENCY)</b>
<b>PAGE: 1 OF 4</b>	

**ISSUE:**

The minimum number of digits required to report a value without loss of accuracy is the number of significant figures. In scientific work, most numbers are measured quantities and are not exact. All measured quantities are limited in significant figures by the precision of the instrument used to make the measurement. It is important to use significant figures when recording a measurement or calculation so that it does not appear to be more accurate than it really is.

There are various approaches for determining significant figures and rounding of numbers. This general guidance is intended to clarify the number of significant figures to be used to report self-monitoring results on Discharge Monitoring Reports (DMRs), state permit limits, determine compliance, or other Water Bureau programs as appropriate.

**AUTHORITY:**

The Natural Resources and Environmental Protection Act, 1994 PA451, as amended, the federal Clean Water Act, and associated administrative rules.

**DEFINITIONS:**

DMR Discharge Monitoring Report

**POLICY:**

It is the Water Bureau policy to follow generally accepted procedures for determining significant figures and rounding numbers to support monitoring, compliance and enforcement activities. It is intended to be consistent with Section 1050 B of *Standard Methods for the Examination of Water and Wastewater* (18<sup>th</sup>, 19<sup>th</sup> and 20<sup>th</sup> editions). Section 1050 B of the 19<sup>th</sup> edition is attached for further discussion and examples.

**REFERENCE TO BUREAU PROGRAMS:** All Water Bureau programs as appropriate.

**METHOD OF DISTRIBUTION:** - Intranet and electronic mail distribution.

**PROCEDURE:** The procedure below is organized into the following topics:

- General Rules
- Rules for Significant Figures
- Rules for Rounding
- Rules for Precision

*This policy provides guidance to staff regarding the implementation and interpretation of laws administered by the DLQ. It is merely advisory, does not affect the rights of or procedures and practices available to the public, and it does not have the force and effect of law.*

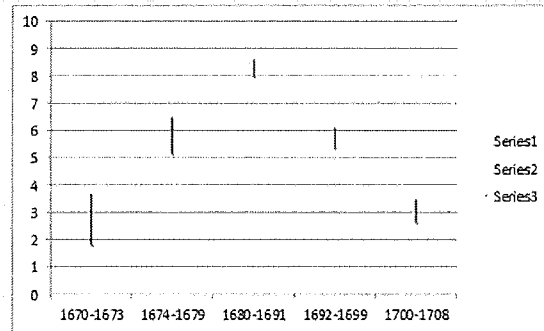
Appendix 4. Sample table and graph of descriptive statistics of groups.

OBJECT ID	Transect	EPR_FT	Area	Average ft	Min	Max
1670	1670	-1.67323	Whitefish Twp C5	-2.731299	-3.67454	-1.67323
1671	1671	-2.19816				
1672	1672	-3.37927				
1673	1673	-3.67454				
1674	1674	-4.59318	Whitefish Twp C4	-5.812555	-6.85696	-4.59318
1675	1675	-5.21654				
1676	1676	-5.67585				
1677	1677	-6.16798				
1678	1678	-6.36483				
1679	1679	-6.85696				
1680	1680	-7.87402	Whitefish Twp C3	-8.322398	-8.92388	-7.28347
1681	1681	-8.89103				
1682	1682	-8.92388				
1683	1683	-8.75984				
1684	1684	-8.66142				
1685	1685	-7.97244				
1686	1686	-7.67717				
1687	1687	-7.28347				
1688	1688	-7.87402				
1689	1689	-8.75984				
1690	1690	-8.72704				
1691	1691	-8.46457				
1692	1692	-6.75853	Whitefish Twp C2	-5.712763	-6.75853	-5.08553
1693	1693	-5.80709				
1694	1694	-6.2336				
1695	1695	-5.479				
1696	1696	-5.18373				
1697	1697	-5.0853				
1698	1698	-5.64305				
1699	1699	-5.51181				
1700	1700	-4.52756	Whitefish Twp C1	-3.0366	-4.52756	-2.49344
1701	1701	-3.44488				
1702	1702	-2.85433				
1703	1703	-2.49344				
1704	1704	-3.01837				
1705	1705	-2.91995				
1706	1706	-2.95276				
1707	1707	-2.55906				
1708	1708	-2.55906				

	Avg	SD	N	95% CL	CO=sd/avg
1670-1673	2.73	0.951019	4	0.932051	0.3483588
1674-1679	5.81	0.822547	6	0.658163	0.1415744
1680-1691	8.3	0.554899	12	0.313958	0.0668553
1692-1699	5.71	0.553852	8	0.383793	0.0969969
1700-1708	3.04	0.631958	9	0.412872	0.2078809

	upper CI	lower CI
1670-1673	2.73	3.662051
1674-1679	5.81	6.458163
1680-1691	8.3	8.613958
1692-1699	5.71	6.093793
1700-1708	3.04	3.452872



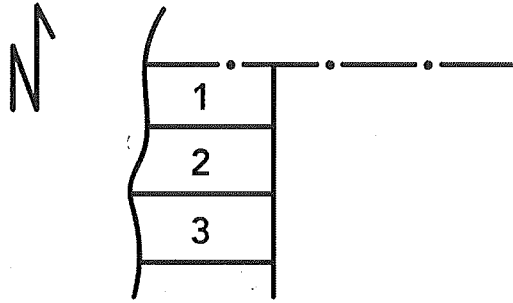
Adjacent areas are significantly different.

Appendix 5. Recession rates and projected recession distances.

RECESSION RATE FT/YR	30-YR PRD	60-YR PRD	RECESSION RATE FT/YR	30-YR PRD	60-YR PRD
1.0	45	75	5.6	185	350
1.1	50	80	5.7	185	355
1.2	50	85	5.8	190	365
1.3	55	95	5.9	190	370
1.4	55	100	6.0	195	375
1.5	60	105	6.1	200	380
1.6	65	110	6.2	200	385
1.7	65	115	6.3	205	395
1.8	70	125	6.4	205	400
1.9	70	130	6.5	210	405
2.0	75	135	6.6	215	410
2.1	80	140	6.7	215	415
2.2	80	145	6.8	220	425
2.3	85	155	6.9	220	430
2.4	85	160	7.0	225	435
2.5	90	165	7.1	230	440
2.6	95	170	7.2	230	445
2.7	95	175	7.3	235	455
2.8	100	185	7.4	235	460
2.9	100	190	7.5	240	465
3.0	105	195	7.6	245	470
3.1	110	200	7.7	245	475
3.2	110	205	7.8	250	485
3.3	115	215	7.9	250	490
3.4	115	220	8.0	255	495
3.5	120	225	8.1	260	500
3.6	125	230	8.2	260	505
3.7	125	235	8.3	265	515
3.8	130	245	8.4	270	520
3.9	130	250	8.5	270	525
4.0	135	255	8.6	275	530
4.1	140	260	8.7	275	535
4.2	140	265	8.8	280	545
4.3	145	275	8.9	280	550
4.4	145	280	9.0	285	555
4.5	150	285	9.1	290	560
4.6	155	290	9.2	290	565
4.7	155	295	9.3	295	575
4.8	160	305	9.4	295	580
4.9	160	310	9.5	300	585
5.0	165	315	9.6	305	590
5.1	170	320	9.7	305	595
5.2	170	325	9.8	310	605
5.3	175	335	9.9	310	610
5.4	175	340	10.0	315	615
5.5	180	345			

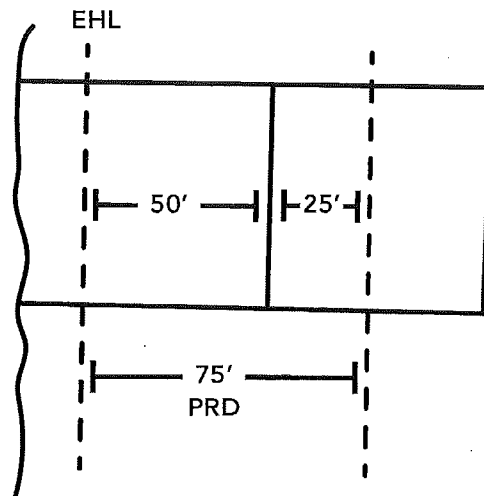
## Appendix 6. Sequence numbering of regulated parcels

Sequence numbers are assigned to lakefront parcels by township from north to south or east to west in ascending order.



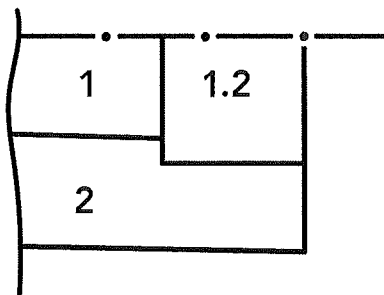
### Second tier parcels

Non-lakefront parcels, or "second tier parcels," are occasionally regulated under the HREA program. When a PRD extends beyond the landward most extent of a lakefront parcel, the parcel (or parcels) directly landward of the lakefront parcel are regulated. For example, if a lakefront parcel extends 50 feet landward of the EHL and the required PRD is 75 feet, the adjacent parcel on the landward side is regulated and has a setback of 25 feet from its most lakeward border.



### Numbering regulated second tier parcels

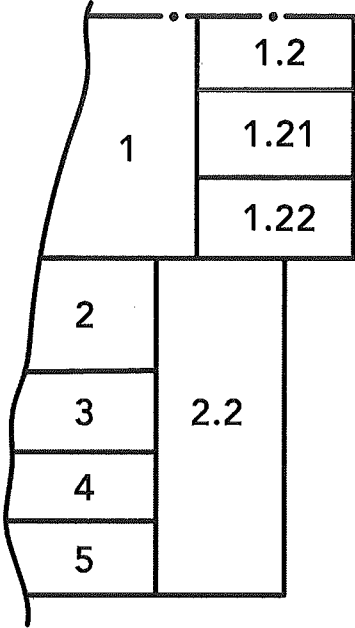
Sequence numbers are also assigned to second tier parcels. Second tier parcels are identified by the sequence number of the northern most lakefront parcel abutting the second tier parcel followed by a decimal (usually ".2" in most cases).

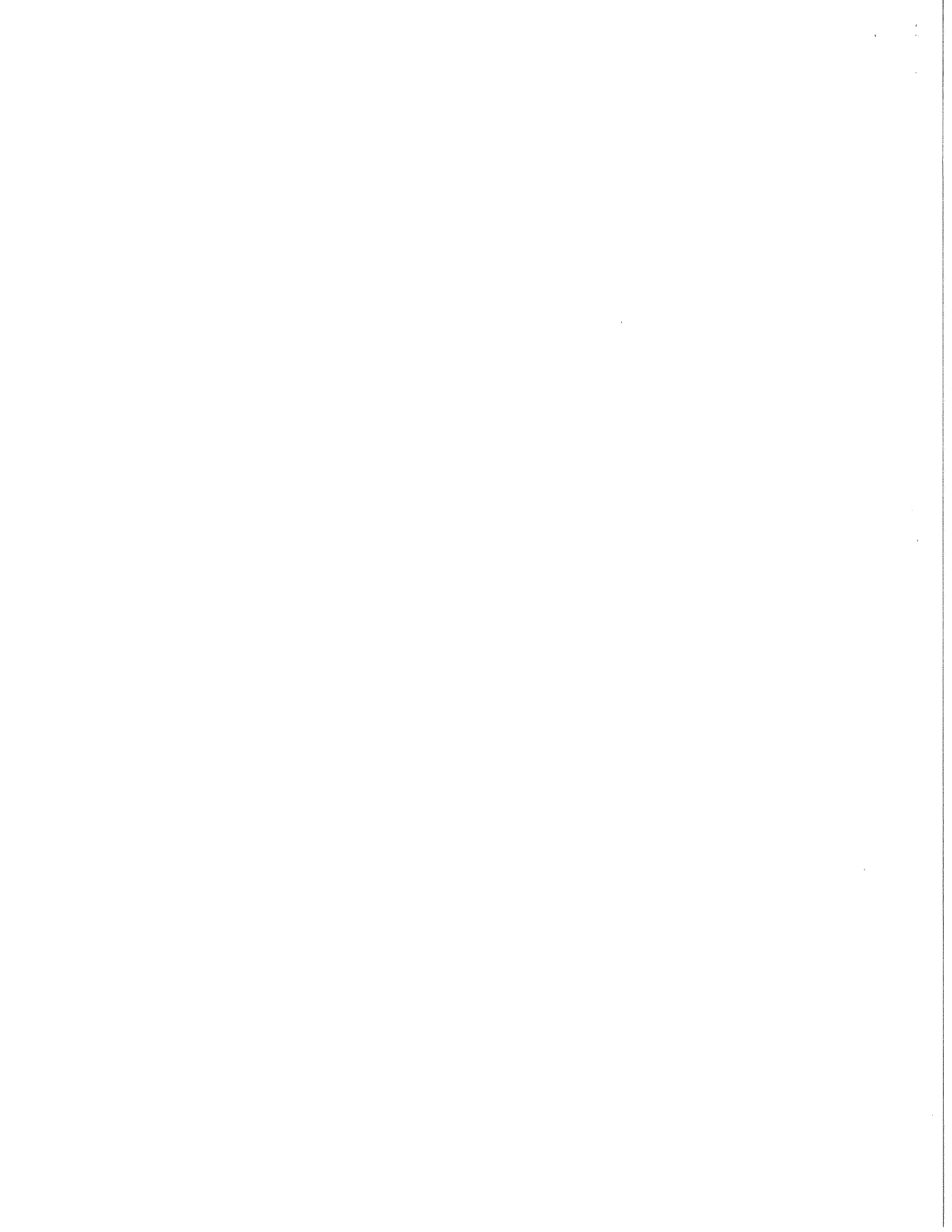




Multiple second tier parcels

When multiple parcels are second tier parcels to one lakefront parcel, the sequence number of the lakeward parcel is used followed by ascending decimals. For example, the northernmost second tier lot would have a sequence number of 1.2, followed to the south by 1.21, 1.22, and so on. When one second tier lot lies landward of several lakefront parcels, the sequence number of the northernmost lakefront parcel is used.





Part 323 - Recession Rate Study, R 281.22 Study Area and Date:

	<b>Step</b>		<b>Substep</b>	<b>County Study</b>	<b>Individual Property Study R 281.22(6)</b>
<b>1</b>	Identify study area and process imagery	<b>a</b>	Identify study area	WRD Staff	Owner/Agent
		<b>b</b>	Identify historic imagery	WRD Staff	Owner/Agent
		<b>c</b>	Identify modern imagery	WRD Staff	Owner/Agent
		<b>d</b>	Scan imagery	WRD Staff	Owner/Agent
		<b>e</b>	Orthorectification of imagery	WRD Staff	Owner/Agent
<b>2</b>	Identify erosion hazard line	<b>a</b>	Identify the historic EHL	WRD Staff	Owner/Agent
		<b>b</b>	Identify the modern EHL	WRD Staff	Owner/Agent
		<b>c</b>	Collect GPS data	WRD Staff	Owner/Agent
		<b>d</b>	Conduct QA and QC	WRD Staff	Owner/Agent
		<b>e</b>	Submit data to WRD in digital format	na	Owner/Agent
		<b>f</b>	Review individual property owner's request	na	WRD Staff
<b>3</b>	Shoreline analysis	<b>a</b>	Identify transect spacing	WRD Staff	WRD Staff
		<b>b</b>	Calculate rates and error	WRD Staff	WRD Staff
<b>4</b>	Determine high risk erosion areas	<b>a</b>	Identify locations of receding shorelines	WRD Staff	WRD Staff
		<b>b</b>	Identify breakpoints	WRD Staff	WRD Staff
		<b>c</b>	Calculate projected recession distances	WRD Staff	WRD Staff
<b>5</b>	Identify affected parcels	<b>a</b>	Develop a digital parcel layer	WRD Staff	WRD Staff
		<b>b</b>	Identify parcels for a designation action	WRD Staff	WRD Staff
		<b>c</b>	Assign sequence numbers to parcels	WRD Staff	WRD Staff
		<b>d</b>	Determine status of affected parcels	WRD Staff	WRD Staff
		<b>e</b>	Update currently designated parcels	WRD Staff	WRD Staff
		<b>f</b>	Compile study statistics, findings, and maps	WRD Staff	WRD Staff

Part 323 - Recession Rate Study, R 281.22 Study Area and Date:

	<b>Step</b>		<b>Substep</b>	<b>County Study</b>	<b>Individual Property Study R 281.22(6)</b>
<b>6</b>	Notification	<b>a</b>	Contact OEA to set webinar date	WRD Staff	na
		<b>b</b>	Set public meeting date, time and location	WRD Staff	na
		<b>c</b>	Notify parcel owners and officials	WRD Staff	na
		<b>d</b>	Advertise webinar and public meeting	WRD Staff	na
		<b>e</b>	Develop presentation for webinar and public meetings	WRD Staff	na
		<b>f</b>	Post recorded webinar on website	WRD Staff	na
		<b>g</b>	Conduct meetings with public and local officials	WRD Staff	na
		<b>h</b>	Respond to comments	WRD Staff	na
		<b>i</b>	Create final maps and write report	WRD Staff	na
<b>7</b>	Designation	<b>a</b>	Write briefing for division management review	WRD Staff	WRD Staff
		<b>b</b>	Create updated parcel lists for local officials	WRD Staff	WRD Staff
		<b>c</b>	Send designation letters by certified mail	WRD Staff	WRD Staff
		<b>d</b>	Respond to appeals	WRD Staff	WRD Staff
		<b>e</b>	Post final maps and report to website	WRD Staff	na
		<b>f</b>	Send updated lists of regulated parcels to local officials	WRD Staff	WRD Staff
		<b>g</b>	Create and send shapefiles upon request	WRD Staff	na
		<b>h</b>	Append new data to HREA statewide database and GIS	WRD Staff	WRD Staff