



**Issue:** **AN ORDINANCE OF THE NIXA CITY COUNCIL REPEALING CHAPTER 105 – ENVIRONMENTAL AND NATURAL RESOURCES, ARTICLE III. – PARKING LOT AND LANDSCAPING WORKSHEET AND REPLACING IT WITH A NEW ARTICLE III. – SINKHOLES AND KARST TOPOGRAPHY**

**Date:** May 9, 2022

**Submitted By:** Planning and Development Department

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## **Background**

The City of Nixa is situated within an area characterized by geologic features commonly referred to as Karst topography. The most well-known karst feature is the sinkhole, which is a natural depression in the surface topography caused by the removal of soil or bedrock by water. Sinkholes become a matter of public interest because the depressions typically hold stormwater runoff, which can be a flood hazard, and they can also provide a more direct conduit to groundwater sources, which increases susceptibility to contamination.

The City of Nixa has regulated development within and around sinkholes for many years. The regulations focus on preventing flood hazards and promoting water quality. While administrating these regulations, it was discovered that one of the flood mitigation provisions was more restrictive than was necessary to promote the public interest. The amendments to the City's sinkhole regulations that accompany this memorandum were crafted in response to that discovery.

## **Analysis**

The proposed amendments to the sinkhole regulations are purposed to clarify the regulations as well as to ensure that the regulations serve the public interests at stake without imposing requirements for which it can be demonstrated that the costs of such regulations outweigh the benefits derived by the community.

To this end, staff has is proposing to modify the requirements concerning how much additional runoff can be added to a sinkhole that is shared by multiple property owners. Presently, development on a property for which there is a sinkhole that is partially located on a neighboring property, the developer has the following options:

1. Obtain a drainage easement from the neighboring property owner to contain the post-development sinkhole flooding area.
2. In the absence of an easement, they may only cause a rise in the water surface elevation of the sinkhole by no more than 1.2 inches.
3. In the absence of an easement, they may study the sinkhole's subsurface outflow rate to demonstrate that additional runoff may be added that will not cause more than the afforded 1.2 inches of rise.



4. In the absence of an easement, they may excavate from within the sinkhole rim to create more storage capacity within the sinkhole so that additional runoff may be added that will not cause more than the afforded 1.2 inches of rise.

After discussing these requirements with stormwater professionals, it became apparent that the restriction to only causing a rise of 1.2 inches was an arbitrary limit that imposed great difficulty on the developing party without providing proportionate protections to the community.

The amendment proposes to allow the water surface elevation within a sinkhole to rise as much as 1 foot (a rise limit more customarily applied in scenarios pertinent to flood prone areas) and that each property within the sinkhole's drainage basin may account for their proportionate share of that afforded 1 foot of rise based on their proportion of the drainage basin's overall area. Additionally, the amendment requires the use of a more impactful storm event in modeling the impacts of runoff on the sinkhole to ensure flood hazard risk is mitigated appropriately.

The result is that the regulations will remain sufficiently protective against flood and water quality threats will also remaining conducive to the profitable and productive use of land.

### **Recommendation**

Staff recommends the approval of this amendment.

1 AN ORDINANCE OF THE COUNCIL OF THE CITY OF NIXA AMENDING CHAPTER  
2 105 OF THE NIXA CITY CODE TO ADD PROVISIONS RELATED TO THE  
3 PROTECTION AND PRESERVATION OF KARST FEATURES.  
4

5  
6 WHEREAS the City of Nixa is situated in an area characterized by Karst  
7 topography, the most well-known of such feature being a sinkhole; and  
8

9 WHEREAS the preservation and protection of Karst features becomes a matter of  
10 public concern, necessitating regulation, because said features can create flooding  
11 hazards and water quality issues for the community; and  
12

13 WHEREAS the Planning and Zoning Commission held a public hearing to consider  
14 the amendments contained herein at their May 2, 2022, regular meeting; and  
15

16 WHEREAS after said public hearing, said Commission recommended approval of  
17 said amendments; and  
18

19 WHEREAS the Council desires to adopt the regulations contained herein to clarify  
20 the City's current regulations and better served the public interest and concerns at stake  
21 regarding Karst features and certain development activity.  
22

23 NOW, THEREFORE, BE IT ORDAINED BY THE COUNCIL OF THE CITY OF  
24 NIXA, AS FOLLOWS, THAT:  
25

26 SECTION 1: Chapter 105, Article III, of the Nixa City Code is hereby amended by  
27 repealing said Article in its entirety and adopting in lieu thereof a new Article, which said  
28 Article shall read as follows:  
29

30 (Note: Language to be added is indicated by being underlined. Language to be removed  
31 is indicated by being ~~stricken~~.)  
32

33 ARTICLE III. – SINKHOLE PRESERVATION REQUIREMENTS  
34

35 Sec. 105-104. – Definitions for this Article.  
36

37 The following words, terms, and phrases, when used in this Article, shall have the  
38 meaning ascribed to them in this section, except where the context clearly indicates a  
39 different meaning:  
40

41 Compensatory Excavation means the removal of earth within a sinkhole so as to  
42 increase the volume of stormwater the sinkhole will hold during a storm event.  
43

44 Critically Sensitive Area means areas that are officially designated by federal or State  
45 regulatory bodies or law as being especially sensitive or susceptible to contamination  
46 hazards from urban runoff including areas such as recharge areas of domestic water

47 supply wells, recharge areas of springs used for public or private water supply, or  
48 recharge areas of caves that provide habitat to endangered species.

49  
50 Development activity means the following:

51  
52 (1) Land disturbance activities which require the issuance of a land disturbance  
53 permit pursuant to Part IV of the Technical Specification Manual of the City of  
54 Nixa.

55  
56 (2) Construction activity which requires the issuance of a building permit pursuant  
57 to the Nixa City Code occurring where there is a known or apparent sinkhole  
58 on the tract or adjoining the tract in which the construction activity is occurring.

59  
60 (3) The subdivision of land, pursuant to the Nixa City Code, where the property to  
61 be subdivided contains a known or apparent sinkhole on the tract or any  
62 adjoining tract.

63  
64 Drainage easement means an easement which is dedicated or granted to the City of  
65 Nixa for the purpose of conveying, storing, or treating stormwater runoff and which  
66 restricts by its terms the placement or location of structures within the easement area.

67  
68 Grading means the movement of soil or rock by motorized equipment, except this  
69 definition shall not apply to the farming of land.

70  
71 Hazard Area, Low means sinkhole drainage areas where runoff is generated by land  
72 uses posing relatively low levels of potential for groundwater contamination. Land uses  
73 considered low hazard areas for the purposes of this Article include:

74  
75 (1) Wooded areas and lawns;

76  
77 (2) Parks and recreation areas;

78  
79 (3) Residential developments served by municipal sanitary sewer, provided that  
80 directly connected impervious areas discharging into the sinkhole area less  
81 than one (1) acre.

82  
83 (4) Low density commercial and office developments provided directly connected  
84 impervious areas discharging to the sinkhole are less than one (1) acre.

85  
86 (5) Discharge from graded areas less than one (1) acre having required sediment  
87 controls.

88  
89 Hazard Area, Moderate means sinkhole drainage areas where runoff is generated  
90 by land uses posing relatively moderate levels of potential for groundwater contamination.  
91 Land uses considered moderate hazard areas for the purpose of this Article include:

92

93 (1) Concentrated discharge from streets, parking lots, roofs, and other directly  
94 connected impervious areas having an area greater than one (1) acre but less  
95 than five (5) acres.

96 (2) Multi-family residential developments and higher intensity office developments  
97 provided that directly connected impervious areas discharging to the sinkhole  
98 are less than five (5) acres.

99  
100 (3) Discharge from graded areas greater than one (1) acre and less than five (5)  
101 acres having required sediment controls.

102  
103 Hazard Area, High means sinkhole drainage areas where runoff is generated by  
104 land uses posing relatively high levels of potential for groundwater contamination. Land  
105 uses considered high hazard areas for the purpose of this Article include:

106  
107 (1) Collector and arterial streets and highways used for commercial transport of  
108 toxic materials.

109  
110 (2) Railroads.

111  
112 (3) Concentrated discharge from streets, parking lots, roofs, and other directly  
113 connected impervious areas having an area greater than five (5) acres.

114  
115 (4) Commercial, industrial, and manufacturing areas.

116  
117 (5) Individual wastewater treatment systems.

118  
119 (6) Commercial feedlots or poultry operations.

120  
121 (7) Discharge from graded areas greater than five (5) acres having required  
122 sediment controls.

123  
124 Heavy equipment means motorized equipment having a gross weight rating of more  
125 than 6 tons.

126  
127 Intervening mitigation feature means an existing or constructed improvement that  
128 controls stormwater runoff by detaining it or providing a water quality benefit.

129  
130 Permit means the form of approval issued by the director to authorize certain  
131 development activity and is issued in compliance with this Article.

132  
133 Responsible party means the fee owner of property or person authorized to act on the  
134 property owner's behalf; or any person allowing, causing, or contributing to a violation of  
135 this Article.

137 Side slop sinkhole means a type of sinkhole which has formed on a sloped surface,  
138 but which has not subsided to the degree that a closed depression is formed. Side slope  
139 sinkholes are usually characterized by a localized flattening of the topography.

141 Simulated Storm Event means the Soil Conservation Service (SCS) Type II storm  
142 event with an annual exceedance probability of one percent and a duration of twenty-four  
143 hours.

144  
145 Sinkhole means any closed depression formed by removal (typically underground) of  
146 water, surficial soil, rock, or other material. The existence of a sinkhole shall be indicated  
147 by the closed depression contour lines of the topographical maps maintained by the city  
148 or as may be determined by a field survey prepared by a professional land surveyor  
149 registered in the State of Missouri. This term shall also include side slope sinkhole as  
150 defined in this Article.

151  
152 Sinkhole drainage area means any area that contributes surface water directly to a  
153 sinkhole or sinkholes.

154  
155 Sinkhole flooding area means the area inundated by runoff from a Simulated Storm  
156 Event based on fully developed conditions in the watershed as well as current zoning and  
157 potential land use.

158  
159 Sinkhole eye means a discrete hole, or shaft, within the floor or slope of a solution  
160 sinkhole that provides a conduit for drainage of storm water to the subsurface drainage  
161 system.

162  
163 Sinkhole rim means the lateral limit of a sinkhole and is defined by the topographic  
164 break, or transition, between the natural ground surface and the sloped sinkhole wall.

165  
166 Solution sinkhole means a sinkhole that forms by dissolution of soluble bedrock, such  
167 as limestone, dolomite, or gypsum. Solution sinkholes typically occur as bowl-shaped  
168 depressions.

169  
170 Stormwater Control Measure means non-structural measures and structural controls  
171 used to meet the flood control detention and water quality requirements of this Article.

172  
173 Watercourse means land which has a conformation so as to give to surface water  
174 flowing from one tract of land to another tract of land a fixed and determinate course so  
175 as to uniformly discharge it upon the servient tract at a fixed and definite point. It shall  
176 include but shall not be limited to ravines, swales, sinkholes or depressions of greater or  
177 less depth extending from one tract and so situated as to gather up the surface water  
178 flowing upon the dominant tract and to conduct along a definite course to a definite point  
179 of discharge upon the servient tract. It shall not be deemed to be important that the force  
180 of water flowing from one tract of land to another has not been sufficient to wear out a  
181 channel or canal having definite or well-marked sides or banks. If the surface water, in

182 fact, uniformly or habitually flows over a given course having reasonable limits as to the  
183 width of the line of its flow, it shall be considered to have a definite course.

184  
185 Sec. 105-105. – Purpose of this Article.

186  
187 The purpose of this Article is to regulate certain development activity in and around  
188 karst topography features to prevent flood hazards and protect water quality. Because  
189 karst features, such as sinkholes, hold stormwater runoff and provide more direct conduits  
190 to sources of groundwater, the treatment of these areas becomes a matter of public  
191 interest.

192  
193 Sec. 105-106. – Certain development activities – prohibited – director to authorizes  
194 certain development activities – when?

195  
196 (a) It shall be a violation of this Article for any person or responsible party to engage in  
197 any development activity on a tract where a sinkhole is present without first obtaining  
198 a permit.

199  
200 (b) It shall be a violation of this Article for any person or responsible party to engage in  
201 any development activity which increases a sinkhole’s discharge rate or involves the  
202 excavating of a sinkhole eye or the installation of disposal wells which divert surface  
203 runoff to the ground water system, without first obtaining a permit.

204  
205 (c) The director may authorize the construction or modification of single-story residential  
206 dwelling within a sinkhole rim under the following conditions:

207  
208 (1) A permit is issued authorizing the construction or modification.

209  
210 (2) All parts of the dwelling are setback at least 25 feet from the sinkhole flooding area.

211  
212 (3) The finished floor elevation of the dwelling is located according to the requirements  
213 of section 105-109 of this Article.

214  
215 (4) A geotechnical investigation conducted by a qualified professional geologist  
216 registered in the State of Missouri concludes that the dwelling’s proposed location  
217 is structurally sound, and the findings of such investigation are provided to the  
218 director.

219  
220 (d) No public street shall be placed below an elevation of at least 1 foot above the sinkhole  
221 flood elevation resulting from the 100-year, 24-hour rainfall with no outlet.

222  
223 (e) Persons or responsible parties seeking approval for golf courses shall provide a  
224 management plan for the use of pesticides and fertilizers if, in the judgment of the  
225 Director, the use of pesticides and fertilizers would impact any sinkholes on the golf  
226 course. Said management plan shall be approved by the Director and deviations or  
227 violations from this plan shall be considered violations of this Section.

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(f) No person shall use pesticides or fertilizers within 25 feet of any sinkhole rim.

(g) No person shall prune trees or other vegetation or remove compromised or dead trees with heavy equipment within 25 feet of any sinkhole rim.

(h) Landscaping and gardening is permitted outside the sinkhole eye provided erosion and sediment control measures are practiced with minimum tillage and mulches.

(i) Construction and placement of incidental landscaping and recreational structures such as playground equipment is permitted except in the sinkhole eye.

(j) No person shall store or apply chemicals or other contaminants within the sinkhole rim.

Sec. 105-107. – Treatment of Sinkholes – Generally.

(a) All development activity shall conform to the following principles, which shall guide the decisions of the director regarding the administration of this Article, which are listed in priority order:

(1) *Avoidance.* Development activity shall be generally prohibited within the sinkhole rim. However, in the event that it can be determined by the Director that avoidance measures are found to be against the public interest of health, safety, and welfare then development activity within the sinkhole rim may be permitted in accordance the principles that follow.

(2) *Minimization.* In cases where avoidance measures cannot be utilized, measures shall be taken to minimize the impact to the sinkhole to the least drastic degree or extent possible as a result of the development activity.

(3) *Mitigation.* In situations where substantial or severe impacts to a sinkhole are unavoidable, mitigation measures shall be utilized as part of the development activity to reduce the potential for hazard to the degree possible under the circumstances.

(b) The alteration of sinkholes is prohibited unless such alterations are required by one of the following conditions:

(1) An underground cavity has caused a collapsed sinkhole to form, and the collapsed sinkhole poses a threat to public health and safety unless repaired or mitigated.

(2) A sinkhole has been altered or filled unknowingly or prior to the passage of these regulations.

(3) Due to the operation and maintenance of streets, utilities, and other public infrastructure.



274  
275 (4) The location of streets, utilities or other public infrastructure would render access  
276 or service to property impractical unless alterations to a sinkhole are permitted.  
277

278 (5) Alteration of a sinkhole is necessary for the construction of a street where the  
279 alignment of the street would cause a traffic hazard unless the sinkhole is altered.  
280

281 (c) When alterations are authorized, the guiding principles referenced in this Section shall  
282 apply to the Director’s determination on whether such measures are to be approved.  
283

284 Sec. 105-108. – Sinkhole Evaluation – Requirements and Contents.  
285

286 (a) Development activity subject to the provisions of this Article shall be prohibited until  
287 the director has issued a permit for such activity. Applicants for such permit shall  
288 provide a sinkhole evaluation to the director which shall be performed by a qualified  
289 professional geologist or stormwater engineer registered in the State of Missouri as a  
290 professional geologist or stormwater engineer. Said sinkhole evaluation shall contain  
291 at least the following:  
292

293 (1) Identification of the topographic rim and identification of the sinkhole drainage area  
294 of all sinkholes which are anticipated to receive stormwater runoff as a result of the  
295 proposed development activity.  
296

297 (2) A flooding analysis of all sinkholes identified in the evaluation which shall include  
298 a description of the methods used in performing said analyses and all supporting  
299 calculations and reports.  
300

301 (3) A geologic analysis of all sinkholes identified in the evaluation which shall include  
302 all subsurface data collected to determine the geologic form and soil profile of the  
303 sinkhole area.  
304

305 (4) Whether the site of the proposed development activity lies within a critically  
306 sensitive area.  
307

308 (5) Identify whether any of the identified sinkholes are located within a low, moderate,  
309 or high hazard area.  
310

311 (6) A description and design of any mitigation measures, including water quality  
312 features, filtration buffers and screens, and structural remediation plans as such  
313 measures are required by the provisions of this Article.  
314

315 (7) Identification of the location and elevation of the lowest enclosed space for all  
316 buildings located within the sinkhole drainage area or to be located within the  
317 sinkhole drainage area due to the proposed development activity.  
318

319 (8) Any additional information or analyses that the director may require and that are  
320 reasonably required to carry out the intent and provisions of this Article.

321  
322 Sec. 105-109. – Flood Prevention Requirements.

323  
324 (a) When a sinkhole evaluation indicates that a sinkhole will receive stormwater runoff  
325 from proposed development activity, the sinkholes shown to receive stormwater runoff  
326 applicants for a permit shall also conduct a flooding evaluation to identify the flooding  
327 impacts of the proposed development activity. The flooding evaluation shall involve  
328 the following assumptions, methods of analysis, and engineering:

329  
330 (1) It shall be assumed that the sinkhole has no subsurface outflow unless a  
331 subsurface outflow rate is determined according to the requirements of subsection  
332 (b)(3)(ii)(C) of this section.

333  
334 (2) The flooding evaluation shall assume the conditions associated with a simulated  
335 storm event, as such term is defined in this Article. Runoff shall be calculated using  
336 the Soil Conservation Service Curve Number Loss Model.

337  
338 (3) If the runoff analysis indicates flooding levels that would overflow the topographic  
339 rim of the sinkhole, then the flooding elevations shall be determined using reservoir  
340 routing methods. In this case, additional downstream evaluation shall be required  
341 to determine that the post-development flow does not exceed the pre-development  
342 runoff flow and that any channelized or concentrated flow is discharged into an  
343 existing public drainage easement, public right-of-way, or existing watercourse.

344  
345 (4) If runoff during the simulated storm event is detained by an intervening mitigation  
346 facility for a period of at least 24 hours before it would enter the sinkhole, then such  
347 volume of runoff may be excluded from the flooding analysis required by this  
348 section.

349  
350 (b) Flooding Elevation Restrictions. The flooding evaluation shall identify the post-  
351 development sinkhole flooding area, which shall be the area prone to flooding impacts  
352 based on the proposed development activity.

353  
354 (1) If the post-development sinkhole flooding area is located entirely within the  
355 property in which the development activity is occurring, a drainage easement shall  
356 be established covering the sinkhole flooding area or an area containing the  
357 entirety of the sinkhole plus the vegetative buffer required by this Article, whichever  
358 is larger.

359  
360 (2) If the post-development sinkhole flooding area is located fully or partially on  
361 another tract which is not owned in fee by the permit applicant, the following  
362 requirements shall apply:

363

- 364           a. The post-development sinkhole flooding area shall be contained within a  
365           drainage easement; and  
366
- 367           b. Any concentrated flow discharged from the proposed development shall be  
368           contained within a drainage easement until it reaches the receiving sinkhole,  
369           existing public drainage easement, public right-of-way, or existing watercourse.  
370           The easement area shall contain the runoff from the storm event with an annual  
371           exceedance probability of one percent (1%) that produces the highest peak  
372           flow, regardless of duration.  
373
- 374           (3) Where it is not possible for a drainage easement to contain the sinkhole flooding  
375           area, a drainage easement shall not be required when the flooding evaluation  
376           indicates that the flooding evaluation of the proposed development activity that:  
377
- 378           a. The proposed development will not cause a rise in the flood elevation within a  
379           reasonable tolerance of 0.1 feet, or  
380
- 381           b. The impacts of both the proposed development and any future development in  
382           the watershed will not impact any existing structures or improvements and will  
383           not increase the flooding elevation by more than one foot. The increase in the  
384           flooding elevation shall be distributed proportionately based on watershed size.  
385           For example, if the development is 20 percent of the watershed, that  
386           development may increase the flooding elevation by 20 percent of one foot or  
387           0.2 feet. This can be determined by calculating the runoff rates and volumes  
388           from the entire watershed, assuming fully developed conditions based on  
389           current zoning and potential future land use and then calculating the resulting  
390           water surface elevation.  
391
- 392           c. The following alternatives, listed in order of priority, may be used individually or  
393           in combination, if needed, to comply with the requirements of this Section:  
394
- 395           (i) Stormwater control measures that reduce runoff volume such as  
396           bioretention, pervious pavement, or similar measures. Small-scale,  
397           distributed applications are preferred over centralized, large-scale practices  
398           in areas with known or suspected sinkholes.  
399
- 400           (ii) Detention Storage. Because traditional detention storage has little or no  
401           impact on the volume of runoff from a site, it is seldom the solution for  
402           impacting the water surface elevation of an adjacent sinkhole. However, in  
403           the case where detention is warranted, the following conditions shall be met:  
404
- 405           (A) It must be shown that the peak basin outflow is less than the existing  
406           peak rate of runoff from the site and less than the discharge rate of the  
407           sinkhole.  
408

409 (B) Compensatory excavation within the rim. Where it can be demonstrated  
410 that compensatory excavation within a sinkhole rim is the only feasible  
411 alternative available to protect downstream private property or public  
412 facilities from the effects of stormwater runoff, compensatory excavation  
413 may be undertaken within the sinkhole rim when expressly authorized  
414 by the Director and where the following conditions are satisfied:

415  
416 1.The compensatory excavation creates no adverse impact on  
417 groundwater, sinkhole stability, flood conditions, or other properties.

418  
419 2. A comprehensive erosion and sediment control plan is developed to  
420 keep sediment confined to the excavation site.

421  
422 (C) Determination of Outflow Capacity of Sinkhole.

423  
424 1. The assumption required by this Article that the sinkhole does not  
425 have any outflow capacity may be overcome according to the  
426 following provisions:

427  
428 a. The stage-discharge characteristics of the sinkhole shall be  
429 estimated by monitoring the sinkhole during at least two storm  
430 events exceeding one (1) inch of runoff in a six (6) hour period.

431  
432 b. In sinkhole complexes, receiving or terminal sinkholes must also  
433 be analyzed if they receive overflow from upstream sinkholes.

434  
435 c. Input rainfall hydrographic shall be determined by a recording rain  
436 gauge or readings from an approved rain gauge at 15-minute  
437 intervals.

438  
439 d. The outflow rate shall be estimated by adjusting the stage-  
440 discharge relationship of the reservoir routing model until the  
441 maximum reservoir state in the model correlates with the  
442 maximum observed stage in the sinkhole. The maximum stage  
443 shall be determined to the nearest 0.1 feet by a field survey  
444 conducted by a registered design professional.

445  
446 e. Stages may be determined by field instruments at the option of  
447 the registered design professional conducting the assessment.  
448 Information regarding the instrument used shall be submitted with  
449 the report.

450  
451 f. Where debris lines are used as evidence of maximum stage,  
452 photographs shall be provided.

453

454 g. If by accounting for the outflow from the sinkhole, the conditions  
455 set forth in this section can be met, no further flooding analysis is  
456 necessary.

457  
458 h. The volume of runoff storage in the sinkhole(s) can be counted  
459 toward stormwater detention requirements, provided that proper  
460 sediment and erosion control measures are provided as set forth  
461 in “Sediment and Erosion Control” and water quality  
462 considerations as set forth in this section can be met.

463  
464 i. If in the opinion of the Director, the outflow capacity of the sinkhole  
465 may be adversely affected by groundwater conditions, the effects  
466 of which may not be adequately determined by observing surface  
467 water stages, the Director may require installation of monitoring  
468 wells in each sinkhole, for the purpose of monitoring groundwater  
469 levels in comparison to surface water levels.

470  
471 (4) The lowest enclosed space for all new buildings within or adjacent to a sinkhole  
472 flooding area shall be:

473  
474 a. A minimum of five feet above the flooding elevation where there is no overflow  
475 from the sinkhole in the simulated storm event; or

476  
477 b. One foot above the flooding elevation determined by the overflow elevation  
478 calculated for the simulated storm event, whenever the difference between the  
479 topographic rim and flooding elevation is less than five feet.

480  
481 (5) When existing improvements are below the flooding elevation resulting from the  
482 simulated storm event, an evaluation of the impacts during higher frequency or  
483 shorter duration rainfall events may be required. It shall be shown that runoff rates  
484 and volumes from a proposed development will not increase the flooding frequency  
485 for any such existing building, structure, or public street.

486  
487 Sc.105-110. – Water Quality Protection.

488  
489 (a) Proposed land use and development within a sinkhole drainage area shall provide  
490 measures for water quality protection according to the following requirements:

491  
492 (1) A twenty-five (25) feet vegetative buffer between any land improvement or land  
493 disturbance and the sinkhole flooding area. The width of the required buffer may  
494 be reduced with the express permission of the Director if it can be demonstrated  
495 that equivalent or better water quality measures will be provided to substitute for  
496 water quality utility of the vegetative buffer.

497

- 498       (2) Development that disturbs a land area exceeding one acre in total within a sinkhole  
499       watershed, shall obtain a land disturbance permit and provide for all necessary  
500       sediment and erosion controls.
- 501
- 502       a. Where the sinkhole is in a critically sensitive area, as defined in this Article,  
503       existing ground cover shall not be removed within thirty (30) feet of the sinkhole  
504       rim and a silt barrier shall be provided around the outer perimeter of the buffer  
505       area.
- 506
- 507       b. A sediment basin is required at each point where concentrated flows are  
508       discharged into the sinkhole. The sediment basin shall be designed according  
509       to the requirements of the City's technical specifications manual.
- 510
- 511       (3) Site design shall minimize directly connected impervious area and incorporate  
512       sheet flow and vegetated conveyance wherever possible within the sinkhole  
513       watershed.
- 514
- 515       (4) Areas classified as low or moderate hazard potential for groundwater  
516       contamination and where flow into the sinkhole occurs only as sheet flow, water  
517       quality requirements can be satisfied by maintaining a permanent vegetated  
518       buffer of at least 30 feet around the sinkhole rim. Use of pesticides and fertilizers  
519       will not be permitted within this buffer area. Animal waste shall not accumulate in  
520       this buffer area.
- 521
- 522       (5) Areas classified as low hazard potential for groundwater contamination where  
523       concentrated flow from directly connected impervious areas of less than one acre  
524       may be discharged into the sinkhole through grass swales and channels. Swales  
525       and channels shall be designed for non-erosion velocities and appropriate  
526       temporary erosion control measures such as sodding, or erosion control blankets  
527       provided.
- 528
- 529       (6) Storage and infiltration basins are required for all areas classified as high hazard  
530       potential for groundwater contamination or areas classified as moderate hazard  
531       for groundwater contamination where concentrated stormwater flows enter the  
532       sinkhole.
- 533
- 534       a. Storage and infiltration basins shall be designed to capture the runoff from  
535       storms up to 1 inch in 6 hours and release runoff over a minimum period of 24  
536       hours. Standard outlet structures for sedimentation and infiltration basins are  
537       shown in Appendix F of the City's technical specifications manual.
- 538
- 539       (7) Developments or land uses that involve the outdoor handling of hazardous  
540       materials or other substances that pose a threat to groundwater quality must  
541       provide a containment plan to show what measures will be taken to assure that  
542       discharges of these materials will be contained and prevented from entering the  
543       sinkhole. Measures may include the installation of warning signs, fencing, or site

544 arrangement that demonstrates an affirmative action to reduce the possibility of  
545 contamination.

546  
547 Sec. 105-111. – Sinkhole Closure.  
548

549 (a) An exemption may be granted to the police of sinkhole avoidance, minimization, and  
550 mitigation upon approval of a plan to close a sinkhole. The sinkhole closure plan shall  
551 include the following information:

552  
553 (1) Reason justifying the closure.

554  
555 (2) Location and description of the sinkhole, including dimensions, depth, and a  
556 description of the sinkhole eye, and one-foot contour interval topographic map of  
557 the sinkhole and its drainage area.

558  
559 (3) Geotechnical report describing the fill plan, source of clean soil fill, soil testing data,  
560 and specifications for compaction.

561  
562 (4) Foundation design report detailing the design of any structures to be constructed  
563 on the closed sinkhole.

564  
565 (5) Stormwater management report that includes pre-development and post-  
566 development flooding analysis and describing how stormwater will be managed  
567 on-site.

568  
569 (6) Groundwater report that assesses the impact of the sinkhole closure on  
570 groundwater quality and groundwater recharge.

571  
572 (7) Site development report that details site grading, roadway construction, utility  
573 construction, and erosion control (best management practices).

574  
575 (8) The sinkhole closure application must be signed and sealed by a professional  
576 geologist registered in the State of Missouri and must be accompanied by a  
577 performance bond in an amount totaling 110 percent of the cost of proposed  
578 closure.

579  
580 (9) The sinkhole closure design must provide for engineered fill with a permeability of  
581 at least 1.0 X 10-6 cm/sec. bearing capacity. Any sinkhole eyes that exist must be  
582 stabilized by construction of a graded filter. A survey of the closed sinkhole must  
583 be filed with the Christian County Recorder of Deeds.

584  
585 ~~ARTICLE III. – PARKING LOT AND LANDSCAPING WORKSHEETS~~

586  
587 ~~Sec. 105-104. Worksheets.~~

588  
589 ~~Buffering Residential Development from Streets (Sample Schedule)~~

590

591 (1) Type of street adjacent to rear yard: \_\_\_\_\_

592

593 (2) Minimum width of required buffer: \_\_\_\_\_

594

595 (3) Linear feet of street frontage toward which rear yards are oriented: \_\_\_\_\_

596

597 (4) Number of plants required: \_\_\_\_\_ shade trees \_\_\_\_\_ evergreen trees \_\_\_\_\_ shrubs

598

599 (5) Percentage of required buffer strip occupied by existing woodland: \_\_\_\_\_

600

601 (6) Six-foot fence or wall or five-foot berm employed in buffer strip: \_\_\_\_\_ Yes \_\_\_\_\_ No

602

603 (7) Number of plants provided: \_\_\_\_\_ shade trees \_\_\_\_\_ evergreen trees \_\_\_\_\_ shrubs

604

605 Parking Lot Landscaped Strip (Sample Schedule)

606

607 (1) Linear feet of street frontage of parking lot: \_\_\_\_\_

608

609 (2) Option selected (1, 2, 3, 4, or 5): \_\_\_\_\_

610

611 (3) Number of plants required: \_\_\_\_\_ shade trees (or equivalent ornamental or evergreen  
612 trees) \_\_\_\_\_ shrubs

613

614 (4) Number of plants provided: \_\_\_\_\_ shade trees \_\_\_\_\_ ornamental trees \_\_\_\_\_  
615 evergreen trees \_\_\_\_\_ shrubs

616

617 Parking Lot Perimeter Area (Sample Schedule)

618

619 (1) Linear feet of parking lot perimeter adjacent to property line: \_\_\_\_\_

620

621 (2) Number of plants required between parking lot and property line:

622

623 \_\_\_\_\_ Shade trees (or equivalent ornamental or evergreen trees

624

625 \_\_\_\_\_ Shrubs

626

627 (3) Number of plants provided between parking lot and property line:

628

629 \_\_\_\_\_ Shade trees \_\_\_\_\_ Ornamental trees \_\_\_\_\_ Evergreen trees \_\_\_\_\_ Shrubs

630

631 **SECTION 2:** The City Attorney, when codifying the provisions of this Ordinance, is  
632 authorized to provide for different section numbers, subsection numbers, and different  
633 internal citation references than those provided herein when such section numbers,  
634 subsection numbers, or internal citation references are in error or are contrary to the intent  
635 of this Ordinance.



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**SECTION 3:** Savings Clause. Nothing in this Ordinance shall be construed to affect any suit or proceeding now pending in any court or any rights acquired, or liability incurred nor any cause or causes of action occurred or existing, under any act or ordinance repealed hereby.

**SECTION 4:** Severability Clause. If any section, subsection, sentence, clause, or phrase of this Ordinance is for any reason held to be invalid, such decision shall not affect the validity of the remaining portions of this Ordinance. The Council hereby declares that it would have adopted the Ordinance and each section, subsection, sentence, clause, or phrase thereof, irrespective of the fact that any one or more sections, subsections, sentences, clauses, or phrases be declared invalid.

**SECTION 5:** This Ordinance shall be in full force and effect from and after its final passage by the City Council and after its approval by the Mayor, subject to the provisions of section 3.11(g) of the City Charter.

**ADOPTED BY THE CITY COUNCIL THIS \_\_\_\_ DAY OF \_\_\_\_ 2022.**

ATTEST:

\_\_\_\_\_  
CITY CLERK

\_\_\_\_\_  
PRESIDING OFFICER

**APPROVED BY THE MAYOR.**

ATTEST:

\_\_\_\_\_  
CITY CLERK

\_\_\_\_\_  
MAYOR

APPROVED AS TO FORM:

\_\_\_\_\_  
DATE OF APPROVAL

\_\_\_\_\_  
CITY ATTORNEY