Analysis of the influence of Nanchang Metro Line 4 on groundwater

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Abstract. Nanchang city subway excavation depth and the Quaternary aquifer layers are located at approximately the same depth. After the completion of the subway, that is equivalent to adding a retaining wall in the phreatic aquifer. The metro line 4 influence on groundwater flow field was analyzed based on the groundwater flow field and the dynamic relationship between groundwater and surface water. The result was that the groundwater level would rise in the area of facing groundwater movement, while others decrease. The influence of metro was apparent at the place where hydraulic contact of Gan River with groundwater was good, and vice versa.

1. Introduction
Nanchang metro project is the forward-looking engineering of Nanchang development. It is of great significance to ease the situation of urban traffic and promote the economic development of Nanchang. Nanchang City belongs to the Poyang Lake basin, located in the leading edge of Poyang Lake. There are abundant groundwater resources in Nanchang area and its water-bearing stratum is very good. The hydrogeological condition is special for Nanchang City to build metro. Nanchang city metro excavation depth and the Quaternary aquifer layers are located at approximately the same depth. After the completion of the metro, that is equivalent to adding a retaining wall in the phreatic aquifer [1]. This will hinder groundwater runoff and lead to changes in the groundwater flow field [2]. Therefore, that is very important significance to research that whether or not to change the original groundwater flow field and cause the related hydrogeological problems after the operation of Nanchang metro. What problems should be paid attention to under the condition of new urban development and in the exploitation, utilization of groundwater resources in Nanchang City.

2. Background
Nanchang City is located in the middle and lower reaches of the Yangtze River, the west coast of Poyang Lake. It has a subtropical humid climate, four distinct seasons. The main surface water bodies are Gan River, Fuhe River, Yudai River, Qingshanhu Lake, Aixihu Lake, Yaohu Lake, etc. The whole terrain is high in the northwest and low in the southeast, Low Mountain hilly, downland and plain are developed, showing the layered geomorphologic characteristics. The tectonic is denudation hillock in the northwest of Gan River, and erosion accumulation plain in the east of the Gan River. The study area is mainly the erosion accumulation plain. The erosion accumulation plain consists of holocene, middle and upper pleistocene alluvium, and the terrain is flat. The Quaternary aquifer consist of middle Pleistocene, upper Pleistocene, Pleistocene sand, sand gravel and gravel. The overlying strata are a relatively aquiclude those are composed of clay, silt soil, and silt clay lens with weak water
conductivity. The lower part is the main storage space of groundwater that composed of gravel [3]. The upper Pleistocene is the most widely distributed among the three times of sand gravel layer, followed by the Holocene, and the distribution of Middle Pleistocene is less. The three formed a unified aquifer with closed hydraulic connection, between the three is the relationship of overlapping, and there is little difference in the elevation of the bottom of the junction.

3. Analysis and results

3.1. Analysis of groundwater effect
Nanchang metro line 4, as shown in Figure 1: High speed passenger west station→North Avenue of Zhanqian Road→Chaoyangzhou South→Fousheng Road→Hongcheng Road→Hongdu Avenue→Nanjing East Road→Shanghai Road→Guowei Road→Huoju Avenue. Planning route length is 24.6 km, and 19 stations were set up. It is the auxiliary line that connection of East District, Chaoyang area and Hongjiaozhou area, and strengthen the rapid connection of the peripheral chip interval. But, metro line excavation position lies 10 meters below the ground. That would obstruct the hydraulic connection between groundwater and Gan River. This is bound to have a corresponding impact on groundwater flow field [4].

![Fig.1 Distribution map of Nanchang Metro Line 4](image)

3.2. Effect result

3.2.1. Xindong Town to Bayi Bridge. The general trend of groundwater flow field in Nanchang city is from the round to the center of the groundwater depression cone. Gan River is northwestern boundary of the study area, and that is an important recharge boundary and discharge boundary of groundwater in Nanchang city. In the section from Xindong Town to Bayi Bridge, The bed of Gan River is located over the holocene sand and gravel layer. The main function of Gan River is to discharge of groundwater that closely related to surfer water (Fig.2-a). But it also can recharge groundwater in the
flood season. The movement direction of groundwater is from east to west, and finally into the Gan River. The upcoming metro line 4 will impede groundwater discharge to Gan River. This will lead to groundwater level rise in the eastern side of the metro line 4 in the section from Dongxin Town to Bayi Bridge. However, the west side of the metro line 4 will be reduced due to runoff reduction.

3.2.2. Bayi Bridge to Jiangxi textile mill. The section from Bayi Bridge to Jiangxi textile mill, Gan River cutted the sand loam and clay layer of Pleistocene. The river bed was deposited of sand and gravel of Holocene, so that kept in close contact with aquifer, strong ability to recharge groundwater (Fig. 2-b). In this section, the groundwater flow direction that was from west to East, the Gan River recharged groundwater. Metro line 4 would hinder the Gan River recharge to groundwater when it was completed. This will inevitably lead to the rise of groundwater level near the side of Gan River, but the level would reduced on the eastern side of the river due to the reduction of supply flow.

3.2.3. Jiangxi textile mill to Youkou. It was affected that Gan River recharged to groundwater, and the recharge was less because there were upper Pleistocene or Holocene sub clay, silty loam in the river bed in the section from Jiangxi textile mill to Youkou. Therefore, the influence of metro line 4 on the groundwater level is relatively weak.

4. Conclusions
According to the above analysis we can see that the metro project will directly affect the existing situation of Nanchang city groundwater environment because of Nanchang urban construction intensive, numerous rivers, and underground pipeline complex. However, this change is often lagging, if the scope and extent of its impact do not be considered fully, not only does not help the expansion of urban space, but also will cause adverse social and economic consequences. Therefore, the Nanchang
metro project must take full account of the regional engineering geological and hydrogeological characteristics, scientific, reasonable, carefully carried out.

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