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ENGINEERING-GEODESIC EQUIPMENT OF THE TERRITORY USED BY USING GEOINFORMATION SYSTEMS

Abstract

The purpose of the scientific article is the implementation of an important part of the agricultural spatial data infrastructure, planning of the domestic economy using geographic information systems (GIS). Taking this direction into account, the work examines the following main elements of designing the domestic economy: location of settlements and economic centers; design of internal roads; placement of external engineering networks; use of types of land reclamation for agricultural purposes; allocation of land for the construction of roads of various categories of local importance; placement of agricultural machinery in land use; conduct a technical and economic analysis of the effective use of road junctions and reclamation works as an engineering structure, as well as systematize the engineering and geodetic process necessary to implement these studies based on GIS technologies. With the help of geographic information systems technologies, it will be necessary to determine the following directions of engineering and geodetic equipment of the territory: Information about road transport and roads, Roads in plan, longitudinal and horizontal profiles, Driving through bodies of water and bodies of water on the road, Road surfaces, Road surveys and design of agricultural roads, The basic principle of organizing the construction, maintenance and repair of agricultural roads.

Keywords*: infrastructure of agricultural spatial data, design of the domestic economy, Geoinformation systems, technologies, geodetic-engineering process, research, region, technical-economic analysis, main elements.*

Introduction

When creating the “National Spatial Data Infrastructure” [1] of the Republic of Kazakhstan, its sectoral component “Agricultural Spatial Data Infrastructure” [2], it is necessary to design the domestic economy, including the accurate determination of transport costs in the transportation of agricultural products, the effective placement of road junctions. Therefore, the use of geographic information systems for the effective location of road junctions, as well as the use of geographic information systems in determining the location of road construction in the first place, is a very pressing issue at the present time. The design of internal roads is an important part of internal land use planning. In addition, a land surveyor, depending on his responsibilities, divides land for the construction of roads of different categories, so it is necessary to have a good knowledge of the main elements of a road as an engineering structure [1 – 5].

With the help of GIS technologies, it will be necessary to determine the following directions of engineering and geodetic equipment of the territory [2; 6 - 8]:

1. Information about road transport and roads.
2. Roads in plan, longitudinal and horizontal profiles.
3. Driving through bodies of water and bodies of water on the road.

4. Road surfaces.

5. Road surveys and design of agricultural roads.

6. The basic principle of organizing the construction, maintenance and repair of agricultural roads.

Methods and materials

The purpose of the scientific article is the use of various types and technologies for reclamation of agricultural land using GIS technologies and the research necessary for the placement of utilities in the complex and on the territory - roads and external utility networks. local significance.

The location of the farm plot under consideration, the feasibility of irrigation and the intended purpose of the planned irrigated plot are indicated. Climatic conditions (air temperature, precipitation, lack of air humidity), evaporation, snow cover and the onset of frost for each ten-day period of the growing season and days of the average daily air temperature change by 5 and 100 s and using an agroclimatic reference book and 3-4 applications the sum of active temperatures is determined air during the growing season. In addition, the degree of humus content, the amount of available nutrients, particle size distribution, the depth of groundwater and its mineralization, as well as the water-physical properties of the soil are described as follows [4; 9 – 12].

The design of the pond is carried out taking into account the economic and economic feasibility of the rational use of water and land resources of the farm territory, taking into account the topographic-geological, hydrological and hydrogeological conditions of the local area, as well as sanitary and natural conditions. protection requirements.

The following indicators are used [13 – 18]:

1. Purpose of the pond: irrigation of agricultural crops on an area of 200-600 hectares with the estimated volume of water; for rural water supply and livestock farming, fish farming or waterfowl breeding;

2. Plan of a beam for constructing a pond and dam for irrigation and the adjacent area on a scale of 1:2000 or 1:5000 with a cross-section of 0.5–1 m;

3. Plan of the arch, pond water collection area on a scale of 1:25000 or 1:50000;

4. The long-term average value of local surface runoff is 75% with a probability of exceeding the calculated runoff, and with a good study of the territory this figure is reduced to 50%. This means that 75 or 50 years 100 melt waters are equal to or exceed the calculated value and ensure that the pond is completely filled with water;

5. The depth of the timber under the pond should be from 6 to 12 m, since a small amount can quickly settle, the water can be warmed by the sun, and it can be filled with vegetation;

6. The longitudinal slope of the beam for constructing a pond should be in the range of 0.005-0.006;

7. The bottom and slopes of the beam must consist of impermeable clay, heavy clay or clayey soils;

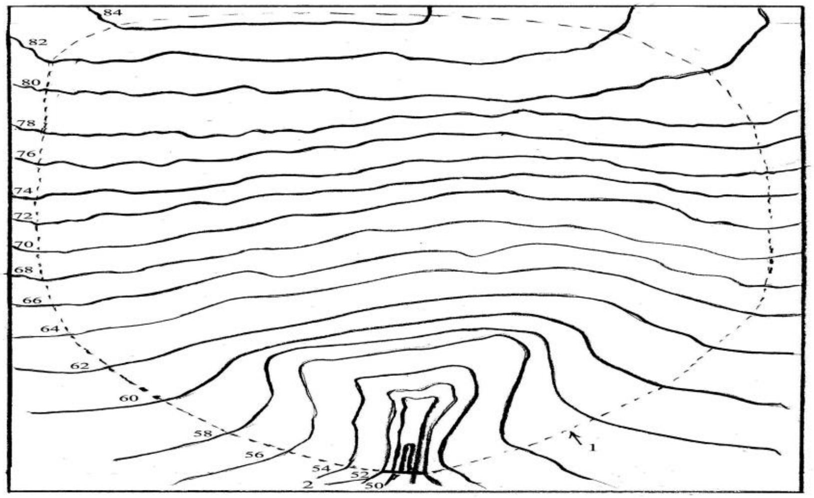
8. The dam beam is located perpendicular to the horizontal (banks) in the narrowest part of the beam, which ensures a minimum amount of excavation work during the construction of the dam;

9. In order to prevent erosion of the dam body, in the presence of springs, the outlet of the dam should be slightly lower than the outlet;

10. Ensure the maximum capacity of the pond with a minimum water level and minimum excavation and economic costs per 1 m3 of water. If there is more than 15-20 m3 of water per 1 m of a pit for a dam, this is considered economical;

11. When placing a pond on local land, it is necessary to prevent water pollution from nearby livestock farms, storage complexes for mineral fertilizers, pesticides, as well as flooding due to rising groundwater levels and populated areas.

One of the main directions of the article is the determination of hydrological conditions using GIS technologies. The drainage basin is part of the territory. Surface local runoff enters the designed reservoir above the dam site. It is limited by the watershed line from the axis of the dam, which is marked on the plan at right angles to the horizontal. This line represents a watershed; inside it there is a drainage area, which can be determined by digital, planimetric or geometric methods, expressed in square kilometers (Fig. 1) [19 -20].



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1 – water body; 2 - axis of the dam.

Figure 1. Cross-section of the pond's catchment area

The hydrological report determines the volume of meltwater runoff from the pond's catchment area. Taking into account the average long-term norm of spring runoff in the region under consideration, as well as the coefficient of variability (variation) of this value (0.6-0.7 for the right bank; for the northern left-bank microdistricts) 0.7 region; central left bank 0.8 and south-eastern microdistrict 0.9) and calculate the modulus coefficient, spring runoff layer and volume of spring runoff of a given probability of exceeding a certain coefficient of variation of spring runoff (Table 1) [14 – 20].

Table 1. The quantity and volume of spring flow entering the pond with a catchment area of 82 km^2. Volume of spring flow probability of overflow, WP, thousand m^3

Probability of exceedance, P, %	Modular coefficient KR at Cv = 0.8	Layer of spring flow probability of overflow, hp, mm	Volume of spring flow probability of overflow, WP, thousand m^3
0,1	5,30	185	15170
0,5	4,19	146	11972
1	3,71	129	10578
3	2,94	103	8446
5	2,57	90	7380
10	2,06	72	5904
25	1,37	48	3936
50	0,80	28	2296
75	0,42	15	1205
80	0,35	12,3	1008
90	0,21	7,3	598
95	0,13	4,5	369
99	0,04	1,4	115

The volume of water with the calculated probability of exceeding the spring runoff layer, flow from the catchment into the pond is calculated using the following formula [14 – 20]:

$$W=1000\cdot F\cdot hp; \qquad (1)$$

where W – is the volume of water, m^3; 1000 – replacement coefficient; F-catchment area, km^2; HP –layer of the spring with the probability of overflow, mm.

The layer of spring wastewater on the territory of the farm under consideration in the area with a probability of 50 and 75% of its average annual value exceeding 35 mm (presence of runoff) will be, respectively, as follows:

hp 50% = Cr h_{av} = 0.80 35 = 28 mm;

hp 75% = Cr h_{av} = 0.42 35 = 15 mm.

Let us determine the volume of runoff for a catchment area of 82 km^2:

- with a 50% probability of exceeding

Wp 50% = 1000·82·(0.80·35)=2296000m^3;

- with a probability of exceeding 75%

Wp 75% = 1000·82·(0.42·35)=1205400m^3.

Using the indicators in Table 1, a theoretical curve of the volumetric flow of a spring with different probability of overflow (providing flow) is formed (Figure 2).

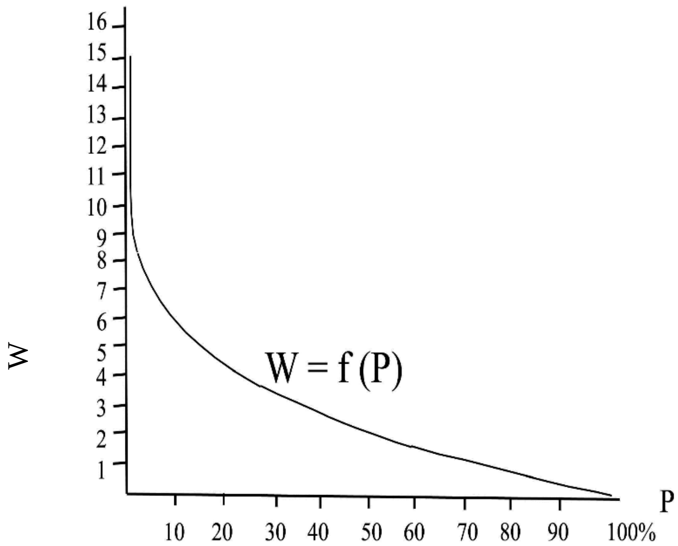

Figure 2. Volume of spring runoff from the catchment taking into account the probability of overflow.

By carrying out water management calculations when designing a pond, characteristic levels and volumes of water are established. The volume level represents the unused volume of water in the pond and serves to collect sediment and overwinter fish for 30-50 years. The depth of the dead water volume is taken to be at least 2-3 m compared to the bottom of the dam and the pond mark.

To determine the actual permissible period of pond siltation, the annual volume of siltation should be calculated using the formula [14 – 20]:

$$Vo = Vx_{\%} \cdot B \cdot \mu; \qquad (2)$$

where Vo – is the annual volume of wetting, kg; Vx% – annual water consumption, estimated forecast probability (supply), m^3; B – the number of floating particles in 1 m^3 of water, kg (0.5-1); μ – sediment porosity coefficient (1.1-1.5).

Normal Support Level (NSL) - This pond is completely filled normally and is located at the bottom of the drainage prism. The height of the drainage prism, that is, the calculated layer of permissible water above the mark, is the water level at which the pond is completely filled normally and is located at the mark of the lower part of the drainage prism. The height of the drainage prism, that is, the calculated layer of permissible water above the mark, is the water level at which the pond is completely filled normally and is located at the mark of the lower part of the drainage prism. The height of the drainage prism, i.e. the calculated layer of water allowed above the mark for water drainage during a flood, is 1-1.5 m.

The forced (maximum) water level is the level observed during the design flood or pond flood. Its sign is placed 1 m below the dam crest, at the level of the height of the discharge prism, that is, 1-1.5 m above the normal support level, taking into account waves (Fig. 3) [14 – 20].

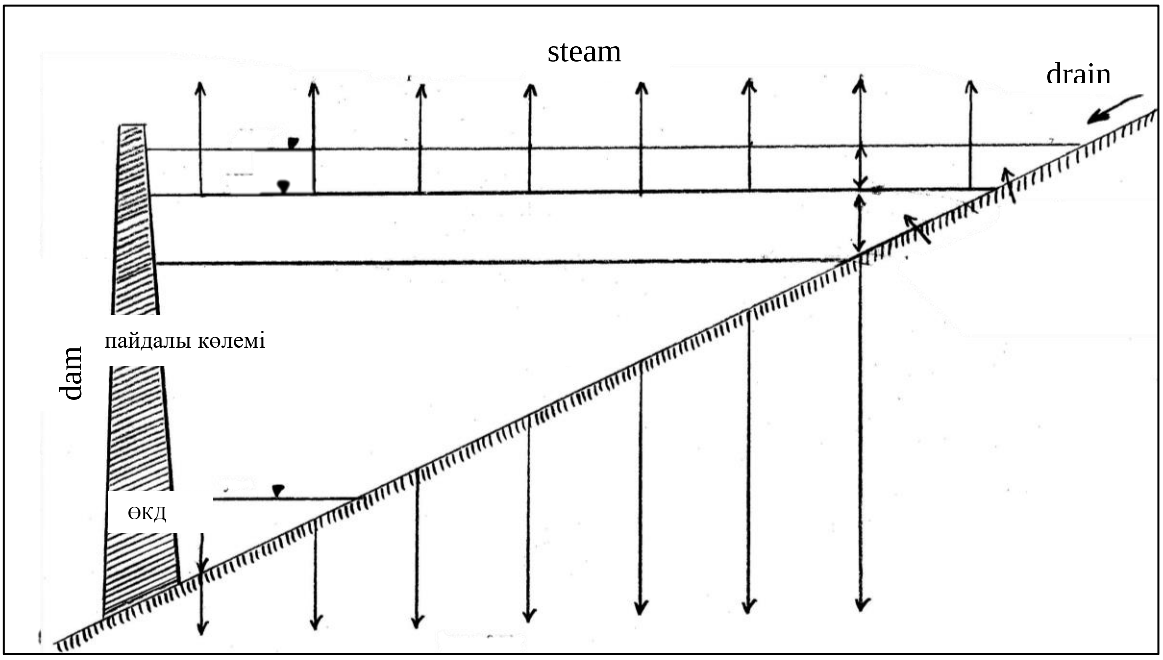

Figure 3. Water levels of ponds and reservoirs.

In the topographic description of a pond or reservoir, a graphical representation of the areas of the water surface S=f(H) and the volume of water W=f(H) is made depending on the filling from the lower horizon to the horizontal corresponding to the normal level of support for the pond. To do this, a territory bounded by a horizontal line and a dam embankment is determined on the pond plan. Drawing the topographic curves of the pond makes it possible to carry out hydrological calculations and use them in the subsequent operation of the pond, since it is possible to determine the volume of water in the pond and the area of the groundwater table. depending on the water depth (Table 2) [14 – 20].

Using these calculations, topographic curves of a pond or reservoir are drawn. To do this, horizontal marks of the area of the groundwater table are placed on the ordinate axis, as well as on the abscissa axis, to determine the curve S=f(H) depending on the depth of filling of the reservoir. The construction of the second topographic curve of the dependence of water volume on the depth of the pond and reservoir is carried out in a similar way.

Table 2. Calculations for constructing topographic curves of ponds and reservoirs

Horizontal designa-tions	Depth of water at the dam (H), m	Area of the groundwater table, ha		Difference between horizontal designations, m	Increase in water volume, thousand. м^3	Volume of water to a given horizon thousand.м^3
		horizontal	Average between horizontal			
41,5	0	0	0,20	0,5	1,01	0
42,0	0,5	0,40	1,05	1,0	10,57	1,01
43,0	1,5	1,71	2,87	1,0	28,70	11,58
44,0	2,5	4,03	5,30	1,0	53,05	40,28
45,0	3,5	6,58	7,83	1,0	78,35	93,33
46,0	4,5	9,09	11,07	1,0	110,75	171,68
47,0	5,5	13,06	15,06	1,0	150,60	282,44
48,0	6,5	17,06	19,57	1,0	195,75	433,04
49,0	7,5	22,09	24,57	1,0	245,70	628,79
50,0	8,5	27,05	29,54	1,0	295,45	874,49
51,0	9,5	32,04	35,06	1,0	350,60	1169,94
52,0	10,5	38,08	35,06	1,0	350,60	1520,54

Results and discussion

Thus, according to the level of the topographic curve of the dead volume of water in the pond, the water depth at the dam is 43.5 m, the horizontal mark corresponds to 2 m, while the area of the groundwater level is 2.87 hectares, the water volume is 28.7 thousand m^3. The progressive (highest) level of water support is located 1 m below the dam crest, i.e. The area of the groundwater table is 35.06 hectares. and the volume of water is 1170 thousand m^3, it is located at the horizontal level of 51.0 [14 – 20].

Normal level of support (NLS), i.e. the total calculated volume of the pond is 1 m below the NLS, i.e. 50.0 at the horizontal level, which corresponds to the formation of a mirror water basin with an area of 27.05 hectares with a volume of water. volume 874.5 thousand m^3.

When calculating various items of water consumption, it is taken into account that the total estimated volume of the pond consists of: 1 – useful volume of water (W_{useful}) for irrigation and water supply; 2 – dead water volume (W_{DWV}); 3 – volume of water loss due to evaporation and filtration (W_{loss}) [14 – 20]:

$$W_{NLS} = Wuseful + W_{DWV} + W_{loss}; \qquad (3)$$

When constructing a pond for land irrigation, the cost of supplying water to the village and livestock complex (W_{water}) is assumed to be approximately equal to 10 percent of the total estimated volume of the pond (W_{CTD}).

Water losses due to evaporation and seepage are determined by the following formula:

$$Wuseful = (h_{percolation} + h_{evaporation}) \cdot S_{avg}.; \qquad (4)$$

where: $h_{percolation}$ is the layer of water loss per percolation per year, m. This value depends on the water permeability of the soil: 0.5 and 0.7 m for clayey and heavy clayey soils, 1.0 m for medium clayey soils and 1.5-2, 0 m for sandy and sandy loamy clay soils. $h_{evaporation}$ – layer of water consumption for evaporation, m. It is assumed that this value is equal to evaporation over this area and a small area. 0.6-0.7 m for forest-steppe, 0.7-0.8 m for black earth steppe; dry brown steppes 0.8-0.9 and semi-deserts 0.9-1.0 m.

The average water surface area of a pond (S_{avg}) is determined by the following formula:

$$S_{avg} = \frac{S_{DWV}+S_{NLS}}{2} \qquad (5)$$

The amount of water that can be used to irrigate the land (Wirrigation) is determined by the following formula:

$$Wirrigation = W_{DWV} - (W_{NLS} + W_{loss} + W_{water}),\ m^3 \qquad (6)$$

The approximate area of irrigated land (S_{avg}) is determined as follows:

$$S_{avg} = \frac{W_{water}}{M_{gross}},\ ha \qquad (7)$$

where M_{gross} is the weighted average total irrigation rate for agricultural crops in crop rotation, taking into account water consumption in canals, pipes, m^3/ha.

$$M_{gross} = \frac{M_{net}}{n},\ m^3/ha \qquad (8)$$

where M_{net} is the net-weighted average rate of irrigation of agricultural crops in crop rotation, allocated to irrigated fields without taking into account losses, m^3/ha. This value depends on the type of plant, the type and degree of aridity of the region, microregion. 1500-1800 m^3/ha for forest-steppe conditions, 1800-2000 m^3/ha for chernozem steppe, 2200-2500 m^3/ha for dry brown steppe and 2500-2800 m^3/ha for deserts; n – coefficient of beneficial effect of the irrigation system. In an open irrigation system with surface watering, 0.6-0.7 is taken, and in a closed irrigation system - 0.8-0.9 with sprinkling.

According to Table 2, the amount of water in the pond is 874.5 thousand m^3 at the normal support level (NSL), and 28.7 thousand m3 at the dead volume level (LDV).

$$W_{loss} = (0.9\ m+0.7\ m) \cdot 149600\ m^2 = 23936\ m^3. \qquad (9)$$

Approximately 10% of the volume of water used for water supply is taken as the normal reference level (NRL) in the eastern pond.

$$W_{water}=874500 \cdot 0.1=87450\ m^3.$$

Substituting the values into formula (6), we find the volume of water for irrigating the land:

W_{water}=874500–(28700+239360+87450)=518990 m^3.

The weighted average irrigation rate is 2350 m^3/ha, the efficiency coefficient of the irrigation network is 0.8, the weighted average irrigation rate is gross.

Conclusion

In conclusion, it should be noted that an important part of the agricultural spatial data infrastructure, designing a domestic farm, using GIS technologies, is to obtain a working design of a pond on a farm at the place of residence, natural and economic conditions, and soil and hydrological conditions. and climatic characteristics of the farm territory, as well as the irrigated crop rotation scheme adopted on the farm. In addition, the correct definition of engineering and geodetic processes is necessary to accurately determine transport costs when transporting agricultural products, quality placement of road junctions and evaluation of land development project options. From space using the ArsGIS program digitalization of a populated area by combining captured images and a situational plan of the area we can create [20]. Therefore, the use of GIS is a very pressing issue at the moment, to conduct a technical and economic analysis of the effective location of road junctions when placing settlements and economic centers in land use, as well as where to build roads in the first place. Using GIS technologies, it will be necessary to determine the following areas of engineering and geodetic equipment of the territory: information about road transport and roads; roads in plan, longitudinal and horizontal profiles; crossings over water bodies and water bodies on the road; road surfaces; road research and design of agricultural roads; the basic principle of organizing the construction, maintenance and repair of agricultural roads.

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ИНЖЕНЕРНО-ГЕОДЕЗИЧЕСКОЕ ИССЛЕДОВАНИЕ ТЕРРИТОРИИ С ИСПОЛЬЗОВАНИЕМ ГЕОИНФОРМАЦИОННЫХ СИСТЕМ

Аннотация

Целью научной статьи является использование различных видов и технологий мелиорации земель сельскохозяйственного назначения с использованием технологий геоинформационных систем (ГИС) и инженерно-геодезических исследований, необходимых для размещения инженерных коммуникаций дорог и наружных инженерных сетей. Поэтому использование геоинформационных систем для эффективного расположения дорожных развязок, а также использование геоинформационных систем при определении места строительства дороги в первую очередь является весьма актуальным вопросом в настоящее время. Проектирование внутренних дорог является важной частью планирования внутреннего землепользования. Кроме того, инженер-землеустроитель в зависимости от своих обязанностей разделяет земли для строительства дорог разных категорий, поэтому необходимо хорошо знать основные элементы дороги как инженерного сооружения. С помощью ГИС-технологий необходимо будет определить следующие направления инженерно-геодезического оборудования территории: информация об автомобильном транспорте и дорогах, дороги в плане, продольном и горизонтальном профилях, проезды через водные объекты и водные объекты на дороге, дорожные покрытия, дорожные изыскания и проектирование сельскохозяйственных дорог, основной принцип организации строительства, содержания и ремонта сельскохозяйственных дорог.

Ключевые слова: инфраструктура аграрных пространственных данных, проектирование внутренней экономики, геоинформационные системы, технология, инженерно-геодезический процесс, исследование, регион, технико-экономический анализ, основные элементы.

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ГЕОАҚПАРАТТЫҚ ЖҮЙЕЛЕРДІ ПАЙДАЛАНУ АРҚЫЛЫ ПАЙДАЛАНЫЛАТЫН АУМАҚТЫ ИНЖЕНЕРЛІК-ГЕОДЕЗИЯЛЫҚ ЖАБДЫҚТАУ

Аңдатпа

Ғылыми мақаланың мақсаты аграрлық кеңістіктік деректер инфрақұрылымын маңызды бөлігі, ішкішаруашылықты жобалауды геоақпараттық жүйелерді (ГАЖ) пайдалану арқылы орындау. Осы бағытты ескере отырып, жұмыста ішкішаруашылықты жобалаудың мынадай негізгі элементтері қарастырылған: елді мекендер мен шаруашылық орталықтарын орналастыру; ішкішаруашылық жол тораптарын жобалау; сыртқы инженерлік желілерді орналастыру; ауыл шаруашылығы мақсатындағы жерлерді мелиорациялаудың түрлерін пайдалану; жергілікті маңызы бар әртүрлі категориялы автомобиль жолдары салынатын жерлерді бөлу; жерді пайдалануда ауыл шаруашылық жабдықтарын орналастыру; жол тораптарын және мелиоративтік жұмыстарды инженерлік құрылыс ретінде тиімді пайдаланылу үшін техника-экономикалық талдау жасау және де аталған зерттеулерді жүзеге асыруда қажетті геодезиялық-инженерлік процессті геоақпараттық жүйелерді технолгиялары негізінде жүйелеу. Геоақпараттық жүйелерді технологияларын пайдаланып, территорияны инженерлік-геодезиялық жабдықтау үшін төмендегідей салаларды анықтау қажет болады: Автомобиль тасымалдары мен жолдары туралы мәлімет, Пландағы, бойлық және көлденең профильдердегі жолдар, Жолдағы субұғыштар және суаққыштар арқылы өткелдер, Жол жамылғылары, Жол ізденістері және ауылшаруашылық жолдарын жобылау, Ауылшаруашылық жолдарын салу,күту мен жөндеуді ұйымдастырудың негізгі принципі.

Кілтті сөздер: аграрлық кеңістіктік деректер инфрақұрылымы, ішкішаруашылықты жобалау, геоақпараттық жүйелер, геодезиялық-инженерлік процесс, зерттеулер, техника-экономикалық талдау, негізгі элементтер.