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AP<sup>®</sup>

CollegeBoard

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# AP<sup>®</sup> Environmental Science

## Sample Student Responses and Scoring Commentary Set 2

### **Inside:**

#### **Free-Response Question 1**

- Scoring Guidelines**
- Student Samples**
- Scoring Commentary**

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**Question 1: Design an Investigation****10 points**

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**(a) (i) Identify** the land use that covers the least amount of area in the Mississippi River watershed, based on the diagram. **1 point**

- Urban

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**(ii) Describe** one way that land use practice at location X in the diagram could contribute to the dead zone in the Gulf of Mexico. **1 point**

Accept one of the following:

- Fertilizer used on croplands is washed into the streams and rivers in the watershed and feeds the growth of algae once it reaches the Gulf.
- Concentrated animal feeding operations generate large amounts of organic wastes that can move into streams and rivers, feeding the growth of algae once it reaches the Gulf.
- Treated or untreated (overflows) sewage released from wastewater treatment plants feeds the growth of algae once it reaches the Gulf.

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**(iii) Describe** one way that urban areas in the Mississippi River watershed could contribute to the dead zone in the Gulf of Mexico. **1 point**

Accept one of the following:

- Wastewater treatment facilities in urban areas may release nutrients in treated wastewater and/or overflows, with this effluent flowing into the Gulf.
- Impervious surfaces in urban areas can increase the movement/runoff of lawn fertilizers or high-phosphate detergents that move onto pavement areas and flow into the Gulf.

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**Total for part (a) 3 points**

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**(b) (i) Describe** how a dead zone affects marine organisms living in the Gulf of Mexico. **1 point**

Accept one of the following:

- Many organisms are forced to migrate or will die as a result of low dissolved oxygen levels in the water.
- Many organisms are forced to migrate or will die as a result of algal blooms that block sunlight from reaching underwater plants (submerged aquatic vegetation).

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**(ii) Describe** one economic effect on communities along the Gulf of Mexico that can result from the presence of the dead zone. **1 point**

Accept one of the following:

- Decreased fish catch/decreased income for fishing industry
- Decreased tourism/lower tourism revenues
- Increased fuel costs for fishing vessels that need to travel farther to locate fish, therefore there will be a decrease in income/profits for fishing industry
- Increased costs for consumers as a result of a limited supply of fish

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- (iii) Describe** one factor that causes the area of the dead zone in the Gulf of Mexico to increase during the summer months. **1 point**

Accept one of the following:

- Increased runoff of nitrates/phosphates/potassium from fertilizer used during the growing season leads to increased algal growth in the summer months.
- Increased precipitation/snowmelt/water volume carries more fertilizer runoff from urban or agricultural areas leading to increased algal growth.
- Higher water temperatures in the summer decrease the concentration of dissolved oxygen as warm water does not hold as much dissolved oxygen as cold water.
- Increased runoff of fertilizer or high-phosphate detergents used in urban areas leads to increased algal growth in the summer months.

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**Total for part (b) 3 points**

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- (c) (i) Identify** a testable hypothesis for the study. **1 point**

Accept one of the following:

- If riparian buffers are present in agricultural areas, then the level of nitrates/phosphates/nutrients downstream will be lower than areas without riparian buffers.
- If riparian buffers are present in agricultural areas, then the level of nitrates/phosphates/nutrients downstream will be higher than areas without riparian buffers.
- If riparian buffers are present in agricultural areas, then the level of nitrates/phosphates/nutrients downstream will remain the same in areas with and without riparian buffers.

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- (ii) Describe** a control that the researchers could use in the study. **1 point**

- Stream sites that are 100 meters downstream from areas without riparian buffer zones

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- (iii) Identify** one water quality test, other than measuring nitrates or phosphates, that the researchers could use to evaluate how riparian vegetation buffers affect water quality. **1 point**

Accept one of the following:

- Turbidity
  - Total suspended solids (TSS)
  - Dissolved oxygen
  - Water temperature
  - Fecal coliform
  - Conductivity
  - pH
  - Biological oxygen demand (BOD)
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- (iv) During the investigation, researchers discovered that some of the land next to one of the streams with a riparian vegetation buffer is going to be converted from cornfields into a large-scale concentrated animal feeding operation. **Explain** one way that this change in land use could alter the results of the study. **1 point**

Accept one of the following:

- There would be a decline in water quality from increased nutrients/increased coliform bacteria in the runoff because there is animal waste in the areas near concentrated animal feeding operations that are high in nutrients/coliform bacteria.
- There would be a decline in water quality from increased turbidity/increased total suspended solids in the streams near the concentrated animal feeding operations because particles from animal wastes enter the stream/there is increased disruption of the stream bed from animals in the water.
- There would be a decline in water quality from increased water temperature because the increased turbidity/suspended solids in streams near the concentrated animal feeding operations absorb sunlight/heat.
- There would be a decline in water quality from increased conductivity because there is increased water temperature/increase dissolved salts in streams near concentrated animal feeding operations.
- There would be a decline in water quality from antibiotics/veterinary drugs in runoff near the concentrated animal feeding operations because antibiotics/drugs are used in livestock operations but not to grow crops.

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**Total for part (c) 4 points**

**Total for question 1 10 points**

Important: Completely fill in the circle that corresponds to the question you are answering on this page.

Question 1

Question 2

Question 3



Begin your response to each question at the top of a new page. Do not skip lines.

- ai) The land use that covers the least amount of area in the Mississippi River Watershed is Urban.
- a ii) The land use at location X is agriculture / cropland. This contributes to the dead zone because excess nutrients & fertilizers used for agriculture run off into streams & cause eutrophication. This creates algal blooms & when the algae decomposes, oxygen is depleted creating a dead zone.
- a iii) Urban areas contribute to dead zones because of excessive runoff. Urban areas are often covered in concrete or other impervious materials which causes more runoff. Excess nutrients in the runoff can cause eutrophication & then hypoxia or a dead zone.
- bi) A Dead zone <sup>would</sup> contribute to the decline of marine organisms populations in the Gulf of Mexico due to a lack of oxygen. Because there will be less dissolved oxygen in the water, many marine organisms will die from asphyxiation.
- b ii) One economic effect would be decrease in employment in fishing industries. Because a ~~dead~~ dead zone would significantly decrease fish populations, less people will be able to make money from fishing.
- b iii) The area of the dead zone increases in the summer months because ~~water~~ warmer water holds less dissolved oxygen. So in addition to hypoxia caused by eutrophication, ~~the~~ oxygen is lost due to the warming of the water

- **Important:** Completely fill in the circle that corresponds to the question you are answering on this page.

Question 1

Question 2

Question 3



Begin your response to each question at the top of a new page. Do not skip lines.

- ci) A testable hypothesis for this study is if vegetation buffers are implemented, water nutrient concentrations will decrease.
- cli) A control researchers could use in this study with no vegetation buffer. This will help to establish that the buffer caused the decrease in nutrient concentration & not some other factor.
- clii) The researchers could use a dissolved oxygen test to see if there is enough oxygen in the water.
- civ) This change in land use can alter the results of the study because CAFOs produce a lot of nitrogen & phosphorus which then runoff into the river. This will increase the nutrient concentration in the water by a lot.

**Important:** Completely fill in the circle that corresponds to the question you are answering on this page.

Question 1

Question 2

Question 3

Begin your response to each question at the top of a new page. Do not skip lines.

- ai) Urban areas cover the least amount of land use
  - aii) The agriculture practices at location X contribute to the dead zone because the flow of spring rain will wash away fertilizers and pesticides, contributing to fertilizer runoff and causing eutrophication in the water.
  - aiii) Urban areas add to the dead zone by increasing the amount of pollutants in the water (like nuclear waste from power plants or endocrine disruptors), which can kill and wash away fish, increasing organic matter.
- bi) A dead zone in the gulf will sicken and kill the fish that live in the area, as well as kill any plants or ground organisms (Coral) that rely on fish.
  - bii) A decrease in the amount of marine ~~life~~ wildlife will mean less fish to catch in fishing excursions, leading to less profitability from fishing careers.
  - biii) During summer months, an increase in temperature will warm the ocean waters, decreasing the Dissolved Oxygen in the water and leading to an increased dead zone.
- ci) If a riparian vegetation buffer were present in an agricultural stream, then the water nutrient concentration will decrease, because the presence of the vegetation will absorb the excess chemicals released from the farms.

- **Important:** Completely fill in the circle that corresponds to the question you are answering on this page.

Question 1

Question 2

Question 3



Begin your response to each question at the top of a new page. Do not skip lines.

- cii) A control for this experiment could be an area with no riparian vegetation buffers downstream, thus giving a base model as to how many nutrients would be in the stream without it.
- ciii) Dissolved Oxygen could be measured.
- civ) This change will greatly alter the results of the study because the concentrated animal feeding farm will increase so many more nutrients (from the animal manure) than the corn farm. The soil will also not be held as well due to the lack of consistent crops, meaning more foreign particles will hit the plants.

**Important:** Completely fill in the circle that corresponds to the question you are answering on this page.

Question 1

Question 2

Question 3



Begin your response to each question at the top of a new page. Do not skip lines.

a) i) The least amount of land use is urban along Mississippi Watershed

ii) The use of ~~land~~ land for agriculture contributes to the dead zone because the use of ~~highly~~ toxic pesticides that ~~increase eutrophication~~ runoff into the Bay river ~~and~~ increasing eutrophication that ~~depletes~~ depletes dissolved oxygen killing aquatic plants.

iii) Urban areas produce high amounts of secondary runoff that flows into the river which contributes to the growing dead zone

b) i) Marine organisms will experience lack of dissolved oxygen which can suffocate the organisms causing them to die off

ii) Fisheries will experience lack of catchable fish to serve people which will decrease their revenue & employment

iii) Summer months would increase due to lack of water to continue the ~~peris~~ water cycle ultimately decreasing precipitation rates

c) i) The areas with riparian vegetation will have better water quality than areas without riparian vegetation

ii) The ~~distance~~ <sup>distance</sup> from the area with or without riparian vegetation

- **Important:** Completely fill in the circle that corresponds to the question you are answering on this page.

Question 1

Question 2

Question 3



Begin your response to each question at the top of a new page. Do not skip lines.

- iii) They can test the dissolved oxygen levels
- iv) The introduction of CAFO will add new ecological factors like methane and animal feces that will change the water's quality.

## Question 1

**Note:** Student samples are quoted verbatim and may contain spelling and grammatical errors.

### Overview

This question focused on the broad categories of watersheds, eutrophication, and land use. Part (a) focused on land use in the Mississippi River Watershed [Topic 4.6 Watersheds, Topic 8.1 Sources of Pollution, Topic 8.2 Human Impacts on Ecosystems, and Topic 8.5 Eutrophication]. Students were expected to apply Practice 2 Visual Representations to explain how environmental concepts and processes represented visually relate to broader environmental issues. This included how land use types may relate to the movement of nutrients through a watershed and how this movement may contribute to the Gulf of Mexico dead zone [Practice 1 Concept Explanation, Topic 5.4 Impacts of Agricultural Practices, Topic 5.10 Impacts of Urbanization, Topic 8.5 Eutrophication].

In part (b) students were asked to describe how the dead zone affects marine organisms, as well as how it might affect the economies of communities along the Gulf of Mexico. Students were also expected to describe a factor that could cause the dead zone to increase during the summer months [Practice 1 Concept Explanation and Topic 8.5 Eutrophication].

In part (c) students needed to apply Practice 4 Scientific Experiments to describe and identify experimental design components, as well as provide an explanation for how the results of an investigation could be altered by the modification of the experiment from a cornfield into a large-scale concentrated animal feeding operation [Topic 5.4 Impacts of Agricultural Practices].

### Sample: 1A

#### Score: 8

One point was earned in part (a)(i) for identifying “Urban.” One point was earned in part (a)(ii) for describing “excess nutrients & fertilizers used for agriculture run off into streams ... creates algal blooms.” No point was earned in part (a)(iii). The response does not include identification of a source of nutrients, such as lawn fertilizers or high-phosphate detergents, in urban areas. One point was earned in part (b)(i) for describing “less dissolved oxygen in the water, many marine organisms will die from asphyxiation” as how a dead zone affects marine organisms. One point was earned in part (b)(ii) for describing “significantly decrease fish populations, less people will be able to make money from fishing” as an economic effect on communities that results from the dead zone. One point was earned in part (b)(iii) for describing “warmer water holds less dissolved oxygen” as a factor that causes the dead zone during the summer months. One point was earned in part (c)(i) for identifying “if vegetation buffers are implemented, water nutrient concentrations will decrease” as a testable hypothesis. One point was earned in part (c)(ii) for describing a control for the study as “no vegetation buffer ... establish that the buffer caused the decrease in nutrient concentration.” One point was earned in part (c)(iii) for identifying “dissolved oxygen” as one water quality test. No point was earned in part (c)(iv). The response does not state animal waste as the source of nutrients.

**Question 1 (continued)****Sample: 1B****Score: 7**

One point earned in part (a)(i) for identifying “urban.” No points were earned in part (a)(ii). No points were earned in part (a)(iii). The response does not connect eutrophication to the dead zone and is therefore an incomplete description. No points were earned in part (b)(i). One point was earned in part (b)(ii) for describing “less fish to catch ... leading to less profitability” as an economic effect on communities that results from the dead zone. One point was earned in part (b)(iii) for describing “increase in temperature will warm the ocean waters, decreasing the Dissolved Oxygen” as a factor that causes the dead zone during the summer months. One point was earned in part (c)(i) for identifying “If a riparian vegetation buffer were present ... then the water nutrient concentration will decrease” as a testable hypothesis. One point was earned in part (c)(ii) for describing a control for the study as “an area with no riparian vegetation buffers downstream.” One point was earned in (c)(iii) for identifying “Dissolved Oxygen” as one water quality test. One point was earned in part (c)(iv) for explaining “concentrated animal feeding farm will increase so many more nutrients (from the animal manure) than the corn farm.”

**Sample: 1C****Score: 4**

One point was earned in part (a)(i) for identifying “urban.” No point was earned in part (a)(ii). No point was earned in part (a)(iii). One point was earned in part (b)(i) for describing “Marine organisms will experience lack of dissolved oxygen which can suffocate the organisms causing them to die” as how a dead zone affects marine organisms. One point was earned in part (b)(ii) for describing “Fisheries will experience lack of eatable fish to serve people which will decrease their revenue” as an economic effect on communities that results from the dead zone. No point was earned in part (b)(iii). No point was earned in part (c)(i). No point was earned in part (c)(ii). One point was earned in part (c)(iii) for identifying “dissolved oxygen” as one water quality test. No point was earned in part (c)(iv).