EQuIP RUBRIC FOR SCIENCE EVALUATION

What's In Your Water?

DEVELOPER: K–12 Alliance

GRADE: 5 | **DATE OF REVIEW:** July 2021

Educators Evaluating Quality Instructional Products

EQuIP Report Template for Units

EQuIP RUBRIC FOR SCIENCE EVALUATION

OVERALL RATING: E/I

TOTAL SCORE: 6

CATEGORY I: NGSS 3D Design Score	CATEGORY II: NGSS Instructional Supports Score	CATEGORY III: Monitoring NGSS Student Progress Score
2	2	2

Click here to see the scoring guidelines.

This review was conducted by NextGenScience using the EQuIP Rubric for Science.

CATEGORY I CRITERIA RATINGS			CATEGORY II CRITERIA RATINGS			CATEGORY III CRITERIA RATINGS		
A.	Explaining Phenomena/ Designing Solutions	Adequate	**A.**	Relevance and Authenticity	Adequate	**A.**	Monitoring 3D Student Performances	Inadequate
B.	Three Dimensions	Adequate	**B.**	Student Ideas	Extensive	**B.**	Formative	Adequate
C.	Integrating the Three Dimensions	Extensive	**C.**	Building Progressions	Inadequate	**C.**	Scoring Guidance	Adequate
D.	Unit Coherence	Inadequate	**D.**	Scientific Accuracy	Extensive	**D.**	Unbiased Tasks/Items	Adequate
E.	Multiple Science Domains	AdequateAdequate	**E.**	Differentiated Instruction	Adequate	**E.**	Coherence Assessment System	Adequate
F.	Math and ELA	Adequate	**F.**	Teacher Support for Unit Coherence	Adequate	**F.**	Opportunity to Learn	Adequate
			G.	Scaffolded Differentiation Over Time	Adequate			

Summary Comments

Thank you for your commitment to students and their science education. NextGenScience is glad to partner with you in this continuous improvement process. The unit is strong in many areas, including a realistic anchor phenomenon, extensive support for eliciting student ideas, and providing multi-dimensional opportunities for students.

During revisions and/or use in the classroom, the reviewers recommend paying close attention to the following focus areas in order to strengthen materials:

- **Identifying key learning targets.** Currently, many elements of all three dimensions are claimed that are not used or developed by students nor assessed. This includes elements of the claimed targeted performance expectations.
- **Clarifying learning progressions**. More organized and comprehensive educator guidance related to what learning students are expected to come in with for all three dimensions and how this learning will be added to throughout the unit could be helpful for educators. This guidance could support the process of establishing and communicating clear and consistent performance expectations for students.
- **Avoiding potential misconceptions that could lead to safety issues**. There is currently no educator guidance or direction to ensure students avoid developing the misconception that filters made from household materials would fully purify contaminated sewer water. Because of the oversimplification of a complex problem that many communities face, there may be some danger in having students think water can be purified with common items. Public water can contain contaminates much more dangerous than sand, salt, and sugar, and require specialized and iterative filtering systems to purify to the point of safe consumption for humans.

Note that in the feedback below, black text is used for either neutral comments or evidence the criterion was met and purple text is used as evidence that doesn't support a claim that the criterion was met. The purple text in these review reports is written directly related to criteria and is meant to point out details that could be possible areas where there is room for improvement. Not all purple text lowers a score; much of it is too minor to affect the score. For example, even criteria rated as Extensive could have purple text that is meant to be helpful for continuous improvement processes; in these cases, the criterion was met; the purple text is simply not part of the argument for that Extensive rating.

Unless otherwise specified, page numbers in the document refer to the page numbers listed on each lesson PDFs.

CATEGORY I

NGSS 3D DESIGN

I.A. EXPLAINING PHENOMENA/DESIGNING SOLUTIONS

I.B. THREE DIMENSIONS

I.C. INTEGRATING THE THREE DIMENSIONS

I.D. UNIT COHERENCE

I.E. MULTIPLE SCIENCE DOMAINS

I.F. MATH AND ELA

I.A. EXPLAINING PHENOMENA/DESIGNING SOLUTIONS

Making sense of phenomena and/or designing solutions to a problem drive student learning.

i. Student questions and prior experiences related to the phenomenon or problem motivate sense-making and/or problem solving.

ii. The focus of the lesson is to support students in making sense of phenomena and/or designing solutions to problems.

iii. When engineering is a learning focus, it is integrated with developing disciplinary core ideas from physical, life, and/or earth and space sciences.

Rating for Criterion I.A. Explaining Phenomena/Designing Solutions	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that learning is driven by students making sense of phenomena because learning is driven by students figuring out an anchor phenomenon, investigative phenomena, and completing a design challenge related to a problem to solve. However, there are many missed opportunities in the learning sequence for students to feel as if they are driving the learning.

A realistic and potentially universally applicable phenomenon and problem — access to clean drinking water — are identified in the unit materials for both educators and students. The identified problem relates to the presented phenomenon. Related evidence includes:

- An anchoring phenomenon is explicitly stated in several places throughout the unit, including but not limited to: "Anchoring Phenomenon: Sewage water is consumed by people, but they do not get sick" (TG, page 5.0.4), "This engineering design learning sequence is built on the anchoring phenomenon: Sewage water is consumed by people, but they do not get sick" (TG, page 5.0.6), "By the end of this lesson, students will be closer to understanding the anchoring phenomenon that sewage water can be processed so that it is drinkable" (TG, page 5.0.11), and "Sewage water is consumed by people, but they do not get sick" (TG, page 5.1.1).
- A problem is identified for the learning sequence: "Water collected from a town may be contaminated" (Intro page 7). After discussing the phenomenon, students are prompted to think about associated problems: "'How might the local water become contaminated? How can we prevent that from happening? How can we fix it? How can we make sure we don't have contaminated water?' Ask students to write their ideas in their science notebook and then share with a partner" (TG, page 5.1.5). Then, students are introduced to the design challenge of solving this problem: "There is a town that is concerned about its local water sources. Many believe that the sources have been contaminated. The town has hired you and your fellow environmental engineers to design a solution to remove the contaminants from the water" (TG, page 5.1.5). Note that the entire design challenge framing is called a problem in the educator prompt rather than differentiating between the problem (second sentence) and the design

challenge (the charge to design a solution to remove contaminants), which may lead to misconceptions about the nature of problems. However, the problem is accurately stated in the unit and lesson overview.

- Introduction, Conceptual Flow: In this infographic, the anchoring phenomenon is shown as "Sewage water is consumed by people, but they do not get sick" but is also paired with the statement, "Matter can be subdivided into particles too small to be seen, but it still exists" (TG, page 5.0.16). It is unclear as to whether the second sentence (which is not a phenomenon) is intended to be part of the phenomenon.
- Lesson 1, Part I, Engage, Step #1: If the design challenge is being charged to find a solution to remove contaminants, as related to the identified problem of the town water be contaminated then the "Drinking Filtered Sewage Water" video used to present the anchor phenomenon includes the solution to the problem in the title as well as in the video during 0:34–0:45 at which time it is stated "They put the waste water through an elaborate three-step process; suck it through microscopic filters, force it through membranes, and blast it with UV lights" (TG, page 5.1.4). While students may not be familiar with this specific vocabulary or understand the complex processes behind each of the steps, a specific solution is presented here in the beginning of the learning sequence, potentially reducing student motivation.
- Lesson 1: Students return to both the anchor phenomenon and the problem at the end of the lesson: "Remind students that the focus is to understand the anchoring phenomenon of sewage water becoming drinkable. We are just beginning to think about the science in the anchoring phenomenon by asking questions. We also need to think about the engineering challenge of how to clean the town water. Ask, "Which of our questions do we think we need to answer to help us explain how sewage water might be made drinkable?" (TG, page 5.1.9).
- Lesson 2: Students see an investigative phenomenon of liquid changing color when an indicator is added, leading them to conclude that something they can't see must also be in the container (TG, page 5.2.6).
- Lesson 3, Part II, Explore 2, Step #32: Students are facilitated to connect back to the design challenge: "Explain that scientists use a property called solubility to determine if one type of matter can dissolve in another type of matter. Ask partners to discuss what this means for the Town Water Samples" (TG, page 5.3.12).
- Lesson 4: Students see the investigative phenomenon of crystals in their mystery jars. Students are prompted to use this phenomenon to think about solving the problem through the design challenge (TG, page 5.4.5).
- Lesson 5, Storyline Link: "By the end of this lesson, students will be closer to understanding the anchoring phenomenon that sewage water can be processed so that it is drinkable" (TG, page 5.5.2). If students are only expected to be "closer" to understanding the anchoring phenomenon at the conclusion of this final lesson it is unclear as to when and how students will be expected to fully understand the phenomenon.
- Lesson 5, Evaluate, Step #25: The final lesson in the unit, concludes with students working individually to "reflect in their science notebook how understanding the properties of matter and identification of matter helps them understand the anchoring phenomenon that sewage water can be made drinkable. They should state that water filtration makes sewage water safe"

(TG, page 5.5.9). If the summation of the unit is that students should be able to articulate that filtration makes water safe to drink, this idea is presented to students in Lesson 1, Step #1 during the video shown. Consequently, students do not need the lesson sequence to figure this out.

Instruction periodically connects student ideas and prior experiences to sense-making. Related evidence includes:

- Lesson 1, Part I, Engage, Step #3: The teacher is told "Connect to student experiences by asking them to respond to the following prompt in their science notebook: 'Think of a time when you wondered if some water was safe to drink. What made you have concerns?'" Another optional prompt is given as a teacher note to help connect personal experiences to motivate sense-making: "If a student seems stuck, ask if they would drink water from a puddle outside the classroom, a lake, or a stream" (TG, page 5.1.4).
- Lesson 2, Part I, Engage, Step #1: The teacher is given prompts to help engage students' personal experiences with the problem: "Ask them to discuss which samples they would be willing to drink and why. Conduct a class discussion about their reasoning. ESRs: I would not drink from jar #1 because it has black things in it (iron filings)" (TG, page 5.2.5). This kind of connection is likely to motivate students to want to learn about how this water could be drinkable.
- Lesson 2, Part III, Explore 2, Step #19: "Next, ask table groups to focus on these two questions: 'What experiences have you had related to poor water quality?' 'How might water contamination affect California (or your location) on a large scale?'" (TG, page 5.2.9). Although elicited, student experiences are not then shared and leveraged to motivate further sense-making.
- Lesson 2, Part V, Explain, Step #25: "Connect the reading with the next demonstration of how contaminants can become invisible in the water. Ask students if they have ever diluted anything—what was their experience? For example, have they ever made orange juice from a can? What did they do to make the orange juice from the concentrate?" (TG, page 5.2.11).
- Lesson 3, Part I, Engage, Step #2: "To help them in their discussion, ask for other examples where they may wonder if there are very small quantities of matter in other items they consume. (Examples may include bacteria on food, gases in air). Ask several students to share their ideas" (TG, page 5.3.6).
- Lesson 3, Part II, Explore, Step #30: "Ask students if they can think of examples of different types of matter mixing together. ESRs: Trail mix has nuts and fruits; punch is made from mixing powder with water; chocolate syrup is added to milk to make chocolate milk. Then ask, 'What examples do you know of mixed solutions that appear clear but have something in them?' ESRs: salt water or sugar water. If you do not get this response, see the Teacher Note box" (TG, page 5.3.12).

Structures are in place for eliciting student questions, almost to the point of redundancy, and students have some opportunities to feel as if the learning is student driven. Related evidence includes:

- Lesson 1, Part I, Engage, Step #1: "Show the Drinking Filtered Sewage Water video. Have the students think-pair-share regarding questions the video caused them to have. As a class, start a Class Question Board by recording questions raised during the discussion on sticky notes" (TG, page 5.1.4).
- Lesson 1, Part II, Engage, Step #7: "'Before you can begin to design a solution to this problem, you must first ask questions about the situation that you can investigate, determine what contaminants, if any, are in the water, and learn the properties of the contaminants. Then you can determine ways in which to remove the contaminants'" (TG, page 5.1.5). Educators are guided to explicitly tell students what they will need to do.
- Lesson 1, Part II, Engage, Step #10: "Then direct students to create a page in their science notebook titled 'Town Water Samples Observations and Wonderings.' Have students write questions they have concerning the contents of the jars they selected both in their science notebook and on sticky notes (one question per sticky note)" (TG, page 5.1.6).
- Lesson 1, Part II, Engage, Step #13: "After students have recorded their observations and developed their models, ask them to share their ideas with their table group...What are you wondering about? What questions, if any, do you want to add to the Class Question Board?" (TG, page 5.1.7).
- Lesson 1, Part III, Engage, Step #15: "Review the Class Question Board with the class, then ask table groups to select their top three questions that they think are the best investigation questions. Use these prompts to help students identify the investigation questions" (TG, page 5.1.8).
- Lesson 1, Part III, Engage, Step #16: A Testable Questions chart is created "At this point, move testable questions that require an experiment to another chart labeled Testable Questions" (TG, page 5.1.8) but is never again revisited or leveraged in the unit.
- Lesson 1, Part III, Engage, Step #17: "Ask table groups to share their top three questions by circling them on the Class Question Board" (TG, page 5.1.9).
- Lesson 1, Part III, Engage, Step #18: "Connect the students' questions to what they will investigate in the upcoming lessons: Quantity of matter in the water (Lesson 2: Finding Impurities in Water) How do we know if the water is clean and safe to drink? How much matter is in the water? Is any amount of contaminating matter safe? Type of matter in the water (Lesson 3: Properties of Matter) How do we know what type of matter is in the jars? Do any jars have no contamination? How do we know if there is other matter in the jar? Cleaning the water (Lesson 4: Cleaning Water and Lesson 5: Separating Mixtures) How can the contaminating matter be removed from the water? How can we make the water clean or safe to drink? Are there different ways to clean the water?" (TG, page 5.1.9). It isn't clear how the teacher will connect the students' questions to what they will investigate; it is possible that a teacher could facilitate students to think their questions were driving the future lessons, but since three future lessons are all listed as part of the teacher prompts, it is more likely that teachers would lay out the entire learning sequence for students ahead of time, reducing the probability that students

would feel like they're driving the instruction. In addition, students are not asked to participate in the process of figuring out what should be investigated first.

- Lesson 1, Part III, Engage, Steps #19–20: "We are just beginning to think about the science in the anchoring phenomenon by asking questions. We also need to think about the engineering challenge of how to clean the town water. Ask, 'Which of our questions do we think we need to answer to help us explain how sewage water might be made drinkable?' Have students work in pairs to review and discuss the questions in their science notebook as well as the questions on the Class Question Board. Hold a class discussion to gather the questions the students think could help in the design process" (TG, page 5.1.9). Students are prompted to select questions that will help them address the design challenge, but a connection is not made between these questions and the lesson plan the teacher previously laid out.
- Lesson 2, Part I, Engage, Step #2: The teacher is told to: "Ask students to think about how they could find out if jar #3 and #4 are contaminated. Have students record ideas in their science notebook, then discuss ideas with their table group or a partner. Ask students to write any new questions they have concerning the Town Water Samples….Review the Design Solutions Question Board categories from Lesson 1. Remind students that their questions are driving the lessons with the goal to develop a plan to help the town clean the water in the sample jars" (TG, page 5.2.5). Although students are told here that their questions are driving the lessons, that was not made clear previously (as mentioned above) so this phrasing of a "reminder" might seem strange to students. Additionally, the student questions about contamination are elicited before the teacher tells the students about indicators (TG, page 5.2.6), so students may feel that the teacher is answering their question rather than just delivering information.
- Lesson 2, Part II, Explore 1, Step #10: "Have students share their revised model in pairs and discuss any new questions they might have. Then facilitate a student-led class discussion about the differences between the two glasses of water and questions the students have that could be investigated to help them identify the matter in the glasses. Write those questions on the Class Question Board. They will be referred to in Lesson 3: Properties of Matter" (TG, page 5.2.7).
- Lesson 2, Part III, Explore 2, Step #21: "Distribute sticky notes to the groups. Provide the prompt: "As a result of the video and your discussion, what new questions does your group have about the Town Water Samples?" Write one question on each sticky note. Ask groups to select 2–3 questions to share with the class. Facilitate a student-driven class conversation about students' questions. Record new student-generated questions on the Class Question Board or the Design Solutions Question Board in the correct category" (TG, page 5.2.9). Note that the action of educator recording student questions in the "correct" category does not necessarily indicate that students are involved in this decision making.
- Lesson 2, Part IV, Explore 3, Step #22: The lesson section immediately following the above evidence ignores that students have just generated questions and prompts educators to focus learning using a prescribed question, "Ask, 'How much stuff is in the water? Where do you think we can find answers to this question?' Facilitate a student-driven conversation about ideas on how answers to this question can be found" (TG, page 5.2.9).
- Lesson 3, Storyline Link: "The next question they will explore is 'How can the properties of matter help us know what is in the water?' This lesson centers on students' understanding that

properties such as magnetism and solubility of matter can be used to identify unknown matter, and those properties can be useful in solving problems such as separating matter into categories or identification" (TG, page 5.3.2). Educators are being given the question they should lead students with, instead of being encouraged to find and connect similar student-generated questions to the desired focus of the next lesson.

- Lesson 3, Part II, Explore 2, Step #30: "Refer to the Class Question Board, finding one that relates to matter mixing with other matter." Students are then asked to think of examples of matter mixing together, and then the teacher is told "Explain that students will have an opportunity to explore their thinking by investigating how different matter mixes with water" (TG, page 5.3.12). The teacher might or might not connect this shift to investigation to students' own questions (this direction is not given explicitly) so students are not facilitated to determine that investigating how different matter mixes with water will answer their questions; they are told what they will do next. This is a minor issue because the disconnect only lasts for a minute; in the next lesson step, student ideas are connected to the investigation: "Distribute the second tray to each pair. Tell them, 'To explore your ideas on solubility, you have these materials to work with'… Ask students what data would be helpful to record when mixing materials" (TG, page 5.3.12).
- Lesson 4, Part I, Explore 1, Step #4: Students are informed by the educator during the transition from Lesson 3 to Lesson 4 what the focus of the lesson will be; student-generated questions are not leveraged to motivate this transition, but there is a generic connection made to student questions. "Tell students, 'Today, we are going to read about some ways to separate different types of matter that are mixed together. This may be helpful in answering some of your questions and provide more ideas for separating the 'stuff' in the town water samples and ultimately cleaning the sewage water'" (TG, page 5.4.6).
- Lesson 5, Explain 1, Steps #15–16: "Allow students to select the question they want to work on from either question board, and provide time for students to research how they might answer that question. After they have recorded their ideas in their science notebook, have them assemble in groups (based on those who worked with the same question) to share their ideas. Ask each group to make a brief presentation of their findings to the whole class" (TG, page 5.5.7). This opportunity allows for student interest and choice to motivate task completion, but there is not a guarantee that students will select similar enough questions to lead to group work and the questions may or may not be directly related to the phenomenon or problem.

Suggestions for Improvement

- Part of the video that presents the anchor phenomenon reveals the solution to the identified problem. Consider selecting a different video to present the anchor phenomenon, prompting educators to not show or verbalize the title, or skipping 0:34–0:45 of the video.
- Currently both the problem and design challenge are defined for students. Students could be supported to participate in defining the problem themselves if the "A Tragedy" video clip were presented earlier in the learning sequence before students are told the problem and design challenge. After viewing the video clip, students could be facilitated to discuss what problems they saw and heard.

- Consider removing the creation and mention of the Testable Questions Chart or providing more guidance about how to make use of this chart throughout the learning sequence.
- The Jordine, Jeff and Ruben Torres resource “Enhancing Science Kits with the Driving Question Board” Science and Children April/May 2013; pages 57–61 to support the development of a question is not a free resource accessible to all educators. Consider using an additional or alternate high-quality resource so that all educators have appropriate supports.
- The materials frequently elicit student questions. Consider providing facilitation prompts to support the teacher in ensuring that students will feel that their questions are driving — not just connected to — the learning. For example:
    - The lesson-specific topics and questions found in Lesson 1, Part III, Engage, Step #18 could be relocated to educator background or front matter so educators are not tempted to state these verbatim to students, thus revealing the sequence, prescribing focus questions, and negating student question asking.
    - Guidance could be provided for the categorization of questions in the body of the lesson.
    - After categorization of questions, students could be facilitated to choose which cluster to answer first without being told the plan for the other lessons. This change would also fit together better with the teacher facilitation in Lesson 2, which already prompts student questions to drive instruction more organically (e.g., the end of the lesson prompts teachers to facilitate student questions to lead into Lesson 3).
    - In Lesson 3, Step #5 (TG, page 5.3.6), consider guiding educators to facilitate students to ask the suggested question rather than educators posing the question themselves.
    - In Lesson 3, Step #30 (TG, page 5.3.12), consider providing explicit guidance for the teacher to connect the students’ questions from the Class Question Board to the need for the next investigation.
- Consider revising the student performance expectations of the concluding task (Lesson 5, Evaluate, Step #25) to be more robust and reflective of the phenomenon, problem, and design challenge.

I.B. THREE DIMENSIONS

Builds understanding of multiple grade-appropriate elements of the science and engineering practices (SEPs), disciplinary core ideas (DCIs), and crosscutting concepts (CCCs) that are deliberately selected to aid student sense-making of phenomena and/or designing of solutions.

i. Provides opportunities to *develop and use* specific elements of the SEP(s).

ii. Provides opportunities to *develop and use* specific elements of the DCI(s).

iii. Provides opportunities to *develop and use* specific elements of the CCC(s).

Rating for Criterion I.B. Three Dimensions	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials give students opportunities to build understanding of grade-appropriate elements of the three dimensions. Students have many opportunities to use elements of all three dimensions, but there is a significant mismatch between elements claimed and evidence of student use in each dimension.

Science and Engineering Practices (SEPs) | **Rating: Adequate**

The reviewers found adequate evidence that students have the opportunity to use the SEPs in this unit. However, there is a significant mismatch between what is claimed and what students do in the unit. In addition, students do not have opportunities to develop new learning about or proficiencies in the SEPs during the learning sequence.

Asking Questions and Defining Problems:

- *Ask questions that can be investigated and predict reasonable outcomes based on patterns ~~such as cause and effect relationships~~.*
    - This element is claimed in the front matter (TG, page 5.0.7), including strikethroughs.
    - This element is claimed in Appendix 5.1 (TG, page 5.1.A1) with the wording and strikethroughs: *Use* (instead of Ask) questions that can be investigated ~~and predict reasonable outcomes based on patterns such as cause and effect relationships.~~ The modification (changing "ask" to "use") is not noted as a change from the original so may be confusing to readers.
        - Lesson 1, Procedure, Teacher Note: "This entire lesson is an Engage, designed to elicit students' prior knowledge, gather their wonderings about contaminated water, and encourage them to think about questions they would like to investigate. Student ideas should be recorded, but not challenged or corrected during this lesson" (TG, page 5.1.4). This evidence only addresses the first portion of the non-modified element.

- Lesson 1, Part II, Engage, Step #11, Teacher Note: "If students need scaffolding on asking questions, ask them what observations will reveal more information. You want to lead students to ask questions that can be investigated" (TG, page 5.1.6). This evidence only addresses the first portion of the element.
- Lesson 1, Part III, Engage, Step #15: "Review the Class Question Board with the class, then ask table groups to select their top three questions that they think are the best investigation questions. Use these prompts to help students identify the investigation questions: What questions can be answered using data from investigations? What type of question would result in learning new information about the potentially dirty water? Which questions are focused? How might we investigate the question? (Do we have the resources in our classroom to do that?) If your question is a yes/no question, how can you change it so that it asks for information (data)?" (TG, page 5.1.8).

- This element is claimed to be part of Lesson 2, in the Introduction: Learning Sequence 3-Dimensional Progressions chart (TG, page 5.0.12) but not included in Appendix 5.2 as an indication that the lesson addresses this SEP.
  - Lesson 2, Part 2, Explore 1, Step #8, Teacher Note states "Cause-and-effect events have causes that generate observable patterns and can be used to explain change. It is important for students to consider this crosscutting concept to help them formulate questions that can be investigated" (TG, page 5.2.6). Contrary to the strikethrough for this element included in the front matter, students use the second half of the element in this example.
  - Lesson 2, Part II, Explore 1, Step #10: "Then facilitate a student-led class discussion about the differences between the two glasses of water and questions the students have that could be investigated to help them identify the matter in the glasses. Write those questions on the Class Question Board. They will be referred to in Lesson 3: Properties of Matter" (TG, page 5.2.7). This evidence only addresses the first portion of the element.
- This element is claimed in Appendix 5.3 (TG, page 5.3.A1), including strikethroughs.
  - Lesson 3: This element is claimed. In the lesson students have many opportunities to ask questions, but do not predict outcomes.
- This element is claimed in Appendix 5.4 (TG, page 5.4.A1), including strikethroughs.
  - Lesson 4: Students are prompted to ask questions about the investigative phenomenon, but not explicitly to predict outcomes related to their questions.
  - Lesson 4, Part I, Explain 1, Step #7: "Students write a response on 5.4.H2: Exit Ticket for each of these questions…Predict what would happen if a mixture of sand and water was left to evaporate" (TG, page 5.4.8). This evidence only addresses the second portion of the element (predict reasonable outcomes).
  - Lesson 4, Part II, Explore 2, Step #18: "Ask table groups to make a prediction stating why their plan will work. They should explain why each part of their plan will work to separate substances from the water. Students should justify the order of their steps in terms of why they think it will allow for the separation of

each substance" (TG, page 5.4.11). This evidence only addresses the second portion of the element (predict reasonable outcomes).

- *Define a simple design problem that can be solved through the development of ~~an object, tool~~, process, or system and includes criteria for success and constraints on materials, time, or cost.*
    - This element is claimed in the front matter (TG, page 5.0.7), including strikethroughs.
    - This element is claimed in Appendix 5.1 (TG, page 5.1.A1) with the following strikethroughs: *Define a simple design problem that can be solved through the development of an object, tool, process, or system ~~and includes criteria for success and constraints on materials, time, or cost.~~*
        - Lesson 1, Part I, Engage, Step #5: "Have students think about the local water supply chain: 'Where does the local water come from? How might the local water become contaminated? How can we prevent that from happening? How can we fix it? How can we make sure we don't have contaminated water?' Ask students to write their ideas in their science notebook and then share with a partner. Ask a few partners to share. Share this prompt: 'I wonder if we can think about how we could make sure we don't have contaminated water?" (TG, page 5.1.5).
        - Lesson 1, Part II, Engage, Step #7: "Introduce the problem: 'There is a town that is concerned about its local water sources. Many believe that the sources have been contaminated. The town has hired you and your fellow environmental engineers to design a solution to remove the contaminants from the water" (TG, page 5.1.5). Students are not defining a problem — they are being directly given the problem.
    - This element is claimed in Appendix 5.3 (TG, page 5.3.A1) with no strikethroughs.
        - Lesson 3: Students continue to think about the given design problem for the learning sequence but do not define any problems.
    - This element is claimed in Appendix 5.4 (TG, page 5.4.A1), including strikethroughs.
        - Lesson 4, Part II, Explore 2, Step #10: "Ask, 'What is the problem we are trying to solve? What are some issues to consider when thinking about how to resolve the problem?' ESRs: The water is contaminated so we have to think about how to get the contaminants out of the water. We have to make observations and use of the properties of matter to identify and quantify the matter in each water sample, and then a design for a separation process can be made" (TG, page 5.4.9).
        - Lesson 4, Part II, Explore 2, Step #12: "Ask table groups to identify the criteria that must be met in order to successfully resolve the water problem. Ask groups to discuss what successfully solving the problem would look like. Ask groups to share ideas and then as a class, agree to the criteria that will be used to determine a solution to the problem. Ask students to record the agreed-upon criteria in the box labeled #2 on 5.4.H3: Environmental Engineer Design Plan" (TG, page 5.4.9).

        - Lesson 4, Part II, Explore 2, Steps #13–14: “Ask table groups to determine the limitations that are present in creating a solution to this problem. Display the materials that are available for use. (See materials list.) Provide names for items if students ask but refrain from providing details on ways to use the tools. Ask table groups to share ideas, and then as a whole class agree to the constraints that will be imposed on the design solution. Then have students write the constraints in the box labeled #3 on 5.4.H3: Environmental Engineer Design Plan” (TG, page 5.4.10).
        - Lesson 4. Part II, Elaborate/Evaluate, Step #24: “Add the agreed-upon problem, criteria, and constraints to the third section of the Design Solutions Question Board (cleaning the water). In Lesson 5: Separating Mixtures, the student-designed plans will be tested and results will be added as final pieces of evidence” (TG, page 5.4.12).
        - This element is included in rubric 5.4.H5 (TG, page 5.4.22).
    - This element is claimed in Appendix 5.5 (TG, page 5.5.A1), with no strikethroughs.
        - Lesson 5, Engage, Step #4: “Ask the students to review their table group’s plan recorded on 5.4.H3: Environmental Engineer Design Plan to get the matter separated and identified. Now that they know the Town Water Sample is #2, does their plan still work? How will knowing the properties of the materials affect the engineer design plan? Does it still meet the criteria and constraints” (TG, page 5.5.5).
        - Lesson 5, Explain 1, Step #12: “Have partners return to their table group. Ask them to compare their observations and results with the criteria and constraints and complete the box labeled #8 on 5.4.H3: Environmental Engineer Design Plan” (TG, page 5.5.7) “Our plan met the criteria or was efficient at __ based on these observations: __Our plan did not meet the criteria or was less efficient at __based on these observations:__” (TG 5.4.19).
- *Use prior knowledge to describe problems that can be solved.*
    - This element is claimed in the front matter (TG, page 5.0.7).
    - This element is claimed in Appendix 5.1 (TG, page 5.1.A1).
        - Lesson 1, Part I, Engage, Step #3: “Connect to student experiences by asking them to respond to the following prompt in their science notebook: ‘Think of a time when you wondered if some water was safe to drink. What made you have concerns?’” (TG, page 5.1.4).
        - Lesson 1, Part I, Engage, Step #5: “Have students think about the local water supply chain: ‘Where does the local water come from? How might the local water become contaminated? How can we prevent that from happening? How can we fix it? How can we make sure we don’t have contaminated water?’ Ask students to write their ideas in their science notebook and then share with a partner. Ask a few partners to share. Share this prompt: ‘I wonder if we can think about how we could make sure we don’t have contaminated water?” (TG, page 5.1.5). Students do not come up with the problem on their own.

- This element is claimed in Appendix 5.3 (TG, page 5.3.A1).
  - Lesson 3: In the lesson, students think about solutions to the given design problem. Students do not come up with a problem on their own.
- This element is claimed in Appendix 5.4 (TG, page 5.4.A1).
  - Lesson 4, Part II, Explore 2, Step #10: When students are asked to define the problem, they are also asked "What are some issues to consider when thinking about how to resolve the problem?" (TG, page 5.4.9). When answering this question, the expected student responses show their prior knowledge.

Developing and Using Models:

- *Develop and/or use models to describe ~~and/or predict~~ phenomena.*
  - This element is claimed in the front matter (TG, page 5.0.7), including strikethroughs.
  - This element in claimed in Appendix 5.1 (TG, page 5.1.A1), including strikethroughs.
    - Lesson 1, Part II, Engage, Step #9: "Ask students to work in table groups. Distribute 5.1.H1: Town Water Samples and have the groups decide who will observe which jar (#1, #2, or #3). It is ok if some students have the same jar as long as each jar is observed by at least one person at the table. All students will observe Jar #4. Ask them to observe the contents of the jar and create a model of what they observe for their jars" (TG, page 5.1.5).
  - Lesson 2: This element is not claimed but is used repeatedly throughout the lesson when students draw and revise models of what they think is contained in the glasses (e.g., TG page 5.2.7).
- *Identify limitations of a model.*
  - This element is claimed in the front matter (TG, page 5.0.7).
  - This element is claimed in Appendix 5.2 (TG, page 5.2.A1).
    - Lesson 2, Part 6, Elaborate, Step #31: In the lesson, students discuss the concept of "parts per billion" and are asked to draw a model of this concept. The teacher is told "Tell students this model does not need to be accurate (they do not need to draw a billion dots)" (Lesson 2, page 12). Students therefore briefly encounter an example of the idea behind this SEP element, but do not apply it themselves.
    - The developing and using models row of Rubric 5.4.H5 includes the statement "Our model explained the relationship between each of the parts and addressed the accuracy and limitations of the model" in the Advanced column (TG, page 5.4.22).
- *Collaboratively develop and/or revise a model based on evidence that shows the relationships ~~among variables for frequent and regular occurring events.~~*
  - This element is claimed in the front matter (TG, page 5.0.7), including strikethroughs
  - Lesson 1, Part II, Engage, Step #9, Teacher Note: "The students will return to 5.1.H1: Town Water Samples in Step 12 where they will revise their models after they gather additional information" (TG, page 5.1.5).
  - This element is claimed in Appendix 5.2 (TG, page 5.2.A1) with no strikethroughs.

- Lesson 2, Teacher Note: "There are multiple models used in this lesson. To help keep track of them, this is a list of how they are used. During:…Step 9: Revise the models of cups A and B to include unseen particles identified with the indicator. Step 14: Revise table group models of the town sample jars showing unobservable particles in jars #1, #2, and #3 but not #4. Step 26: Investigate parts per billion (ppb) and develop new models on the worksheet showing parts per billion. Step 27: Revise table group models of the town sample jars now showing parts per billion. Step 30: Assess students' development and use of models for understanding parts per billion. Step 32: Develop models for their evidence in board presentation" (TG, page 5.2.2).
- Lesson 2, Part II, Explore 1, Step #4: "Show the two glasses of water, one marked A and one marked B, that you prepared in the Advance Preparation. Ask student pairs to use what they know about making models to draw in their science notebook a model of what they see in the two glasses. As students draw their models, look for them to depict these ideas: a single shape that represents a water particle, particles loosely drawn in the glass to represent a liquid, parts labeled" (TG, page 5.2.5).
- Lesson 2, Part II, Explore 1, Step #9: "Ask students to review their initial model of the two glasses (Step 4) and modify their models to reflect the fact that there is a difference between the matter in the two glasses, which is why the water in the glasses looks different" (TG, page 5.2.7).
- Lesson 2, Part II, Explore 1, Step #14: "Ask students, based on this new information, to revise their models from Lesson 1; Town Water Samples (Step 1 in this lesson) and share with their table group" (TG, page 5.2.7).
- Lesson 2, Part V, Explain, Step #28: "Remind students that they have revised their model from Lesson 1 regarding the 4 jars based on the indicators. They now know about parts per billion. Ask pairs to discuss how this information can be added to their model. Then ask students to revise their model" (TG, page 5.2.12).

Planning and Carrying Out Investigations:

- *Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence,* ~~*using fair tests in which variables are controlled and the number of trials considered.*~~
    - This element is claimed in the front matter (TG, page 5.0.8), including strikethroughs.
    - This element is claimed to be part of Lessons 2–5, in the Introduction: Learning Sequence 3-Dimensional Progressions chart (TG, page 5.0.12) but not included in Appendix 5.3–5.5 as an indication that the lessons address this SEP element.
    - There is very limited evidence to support that students contribute to the collaborative planning of investigations to produce data. Students do however plan a solution design (water filter).
    - This element is claimed in Appendix 5.2 (TG, page 5.2.A1) with no strikethroughs.

        - Lesson 2, Part II, Explore 1, Step #11: "Ask students what they might do to see if there are any unobservable contaminants in the Town Water Samples ESR: We could use an indicator" (TG, page 5.2.7). This is a limited attempt at working toward this element.
        - Lesson 2, Part VII, Evaluate, Step #40: "Look for a question on the Class Question Board or on the Design Solutions Question Board that is similar to 'If there is stuff in the water, what is it?' If that question is not there, prompt students with: 'Now that you know a clear glass of water can still be contaminated, how could a scientist investigate the types of matter in the Town Water Sample Jars in order to determine all the contents in each jar? Be sure to consider the steps and requirements that scientists need to address in order to make sure the results are reliable'" (TG, page 5.2.15). It seems to be implied that students are being asked to participate in a discussion related to planning an investigation, but directions are not clear enough to make this connection explicit for the educator or student.
    - This element is not claimed as a learning target for Lesson 4, but the teacher is told "Facilitate a class discussion on the importance of conducting multiple trials to validate results" (TG, page 5.4.11). This direction helps students build toward this element.
- *Evaluate appropriate methods and/or tools for collecting data.*
    - This element is claimed in the front matter (TG, page 5.0.8).
    - This element is not claimed as a learning target for Lesson 2, but students are asked to complete the following writing prompts "Our group results are similar to__ because__. Our group results are different from__ because__. What are some reasons for similarities and differences in data?" (TG, page 5.2.23) to compare their results. Therefore, students may begin to evaluate their processes used to complete the parts per billion task.
    - This element is claimed in Appendix 5.3 (TG, page 5.3.A1).
        - Lesson 3, Part II, Explore 2, Step #37: In the lesson, the teacher is told "Have a discussion about weighing matter. Ask, 'What are the appropriate tools? What should you keep in mind when weighing something?' Have table groups discuss and share ideas. ESRs: need to be accurate in measuring the weight; need to use a scale with numbers; need to 'center' the scale so that it starts at zero; need to make sure that you are measuring the weight of the item and not the weight of the item plus the container it is in"… "Encourage discussion and additional examples of appropriate methods for collecting data about objects' weight" (TG, page 5.3.13).
- *Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.*
    - This element is claimed in the front matter (TG, page 5.0.8).
    - This element is claimed in Appendix 5.2 (TG, page 5.2.A1).
        - Lesson 2, Part II, Explore 1: In the lesson, students make observations of what happens when an indicator is added and propose the idea of using an indicator

to test whether there are unobservable contaminants in the water (TG, pages 5.2.6–5.2.7).

- This element is claimed in Appendix 5.3 (TG, page 5.3.A1) with the following strikethroughs: *Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon ~~or test a design solution~~.*
  - Lesson 3: Students make observations of mixtures of water and different types of matter and are told the data will help them solve the design challenge (TG, page 4.3.14).
- This element is claimed in Appendix 5.4 (TG, page 5.4.A1) .
  - Lesson 4: There is an optional investigation described in the lesson. Note that the description of how this SEP is used in Lesson 4 on page 12 of the Introductory document seems to be from a prior version of the materials — it seems to refer to a different investigation.
- This element is claimed in Appendix 5.5 (TG, page 5.5.A1).
  - Lesson 5, Explore, Step #11: "Ask students to record their observations and results in the box labeled #7 on 5.4.H3: Environmental Engineer Design Plan" (TG, page 5.5.6).

- *Test two different models of the same proposed object, tool or process to determine which better meets criteria for success.*
  - This element is claimed in the front matter (TG, page 5.0.8).
  - This element is claimed in Appendix 5.5 (TG, page 5.5.A1).
    - Lesson 5, Explore, Step #11: "Ask student to gather materials and set up their design solution. When the design is complete and ready or testing, give the students the large plastic cup containing the Town Water Sample (Step 1 in Advance Preparation). Ask students to record their observations and results in the box labeled #7 on 5.4.H3: Environmental Engineer Design Plan. Ask partners to refer to 5.5.C1: Criteria for Observations to support their recording of their observations" (TG, page 5.5.6). Note that student pairs only test their single solution design once; other pairs test their designs and the different designs are compared. Multiple designs are not tested by the same students.
    - Lesson 5, Explain 2, Step #17: "Ask students to individually write in their science notebook reflecting on the different design processes created by their peers and the data showing how each design worked in separating the various matter in the water samples" (TG, page 5.5.8).

Analyzing and Interpreting Data:

- Lesson 4, Toolbox 5.4, Handout Rubric: Both of the elements listed for the **Analyzing and Interpreting Data** criteria of the rubric are above students' grade level: *Analyze data to define an optimal process or system that best meets criteria for success. Consider limitations of data analysis (e.g., measurement error), and/or seek to improve precision and accuracy of data and methods (e.g., multiple trials)* (TG, page 5.4.23).

    - Lesson 5, Explain 2, Step #19: Student are asked to "reflect on their process for their design by referring to 5.4.H5: Rubric (from Lesson 4: Cleaning Water). Ask them to reflect on the last four components (planning and carrying out investigations, analyzing and interpreting data, using mathematics and computational thinking, and designing solutions)" (TG, page 5.5.8). However, as stated in the bullet above, the two elements listed on the rubric as criteria for **Analyzing and Interpreting Data** are above grade level.
- *Analyze and interpret data to make sense of phenomenon, using logical reasoning, mathematics, and/or computation.*
    - This element is claimed in the front matter (TG, page 5.0.8).
    - This element is claimed in Appendix 5.2 (TG, page 5.2.A1).
        - Lesson 2, Part VI, Elaborate, Step #32: "Now have students work with a partner to analyze and interpret all of the school graphs. The following prompts can be provided to guide student analysis of the data: Is the water clean at these schools? (Is there other matter in the water?) How do you know?" (TG, page 5.2.13).
    - This element is claimed in Appendix 5.3 (TG, page 5.3.A1).
        - Lesson 3: In the lesson, students analyze their observation that black spots collect on the outside of a magnet and determine that this means a metal might be present (TG, page 5.3.7).
    - This element is claimed in Appendix 5.4 (TG, page 5.4.A1), but there is no evidence that the lesson includes opportunities for data analysis.
    - This element is claimed in Appendix 5.5 (TG, page 5.5.A1).
        - Lesson 5: Students make observation of their design solution system and are asked to analyze the results. For example, "How efficient was their separation? Did they get back everything they started with? What information is needed to answer this question?" (TG, page 5.5.7).
- *Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings*
    - This element is claimed in the front matter (TG, page 5.0.8).
    - This element is claimed in Appendix 5.2 (TG, page 5.2.A1).
        - Lesson 2: Students are supported to compare their group data (e.g., TG page 5.2.23).
    - This element is claimed in Appendix 5.3 (TG, page 5.3.A1).
        - Lesson 3, Part I, Explore 1, Step #17: After students sort their materials, "Have teams review their sorting, asking them to compare and contrast their data to find patterns" (TG, page 5.3.8).
    - This element is claimed in Appendix 5.4 (TG, page 5.4.A1), but there is no evidence to support that the lesson includes comparison of data collected; instead, students compare plans.
    - This element is claimed in Appendix 5.5 (TG, page 5.5.A1).
        - Lesson 5, Explain 2, Step #17: "Ask students to individually write in their science notebook reflecting on the different design processes created by their peers and

the data showing how each design worked in separating the various matter in the water samples" (TG, page 5.5.8).

- *Represent data in tables and/or various graphical displays ~~(bar graphs, pictographs and/or pie charts)~~ to reveal patterns that indicate relationships.*
  - This element is claimed in the front matter (TG, page 5.0.8), including strikethroughs.
  - This element is claimed in Appendix 5.3 (TG, page 5.3.A1), including strikethroughs.
    - Lesson 3, Part I, Explore 1, Step #16: In the lesson, students "make a group record showing the items that were sorted and the property used to group them" (TG, page 5.3.8).

Constructing Explanations and Designing Solutions

- *Apply scientific ideas to solve problems.*
  - This element is claimed in the front matter (TG, page 5.0.8) as ~~Constructing Explanations and~~ Designing Solutions
  - This element is claimed in Appendix 5.4 (TG, page 5.4.A1).
    - Lesson 4, Part 2, Explore 2, Step #16: "Ask table groups to design and write a process/plan in the box labeled #5 on 5.4.H3: Environmental Engineer Design Plan. The plan must result in a solution to the #1: problem they identified, which most closely meets #2: the criteria they established within #3: the limitations they identified using the scientific information they learned in the previous lessons. Circulate and encourage groups to address how data will be collected. This data can be qualitative and/or quantitative" (TG, page 5.4.10).
    - In Lesson 4, Handout 5.4.H2 students are asked to answer the question, "Based on your learning so far, what suggestions would you give city leaders regarding the town's drinking water problem?" (TG, page 5.4.16).
    - In Lesson 4, Handout 5.4.H2 students are asked to, "Apply scientific information you have learned from previous lessons and the reading to help you solve the problem" (TG, page 5.4.17).
  - This element is claimed in Appendix 5.5 (TG, page 5.5.A1).
    - Lesson 5, Engage, Step #4: Students are asked "Now that they know the Town Water Sample is #2, does their plan still work? How will knowing the properties of the materials affect the engineer design plan?" (TG, page 5.5.5).
- *Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.*
  - This element is claimed in the front matter (TG, page 5.0.8).
  - This element is claimed in Appendix 5.4 (TG, page 5.4.A1).
    - Lesson 4: In the lesson, students justify their ideas for design solutions, but are not explicitly prompted to use data and evidence — just scientific ideas.
  - This element is claimed in Appendix 5.5 (TG, page 5.5.A1) with the following strikethroughs: Use evidence (e.g., measurements, observations, patterns) to ~~construct or support an explanation or~~ design a solution to a problem.

        - Lesson 5, Explain 1, Step #12: Students are asked “Why did you use this particular material? How did it work? What is your data?” (TG, page 5.5.7).
        - Even though the strikethrough in the learning target for this lesson eliminates “construct or support an explanation,” Lesson 5, Evaluate, Step #23 states “Have students work in pairs to discuss what they learned from separating the mixture in Town Water Sample #2. Based on that information, they must develop an explanation that describes how a water filter works. They should include their understanding of: particle size, the properties of materials that are used to identify them, the scale of the filter, water, and contaminants” (TG, page 5.5.8).
- *Identify the evidence that supports particular points to an explanation.*
    - This element is claimed in the front matter (TG, page 5.0.8).
    - This element is claimed in Appendix 5.5 (TG, page 5.5.A1).
        - Lesson 5, Explain 1, Step #14: Students are asked “Is the residue from the evaporation salt or sugar? What information is needed to answer this question?” and “How efficient was their separation? Did they get back everything they started with? What information is needed to answer this question?” (TG, page 5.5.7).
- *Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.*
    - This element is claimed in the front matter (TG, page 5.0.8).
    - This element is claimed in Appendix 5.5 (TG, page 5.5.A1). Students compare multiple solution designs and revise their solutions.
        - Lesson 5, Engage, Step #4: “Ask the students to review their table group’s plan recorded on 5.4.H3: Environmental Engineer Design Plan to get the matter separated and identified. Now that they know the Town Water Sample is #2, does their plan still work? How will knowing the properties of the materials affect the engineer design plan? Does it still meet the criteria and constraints” (TG, page 5.5.5).
        - Lesson 5, Explain 1, Step #12: “Have partners return to their table group. Ask them to compare their observations and results with the criteria and constraints and complete the box labeled #8 on 5.4.H3: Environmental Engineer Design Plan” (TG, page 5.5.7) “Our plan met the criteria or was efficient at __ based on these observations: __Our plan did not meet the criteria or was less efficient at __based on these observations:__” (TG, page 5.4.19).

Using Mathematics and Computational Thinking:

- This element is not claimed in the front matter, or in an individual lesson.
- Lesson 4, Toolbox 5.4, Handout Rubric: One of the two elements listed for the **Using Mathematics and Computational Thinking** criteria of the rubric is *Apply mathematical concepts (e.g., ratio, rate, percent, measurement, time) to solve problems,* which is above students’ grade level (TG, page 5.4.23).

- Lesson 5, Explain 2, Step #19: Student are asked to "reflect on their process for their design by referring to 5.4.H5: Rubric (from Lesson 4: Cleaning Water). Ask them to reflect on the last four components (planning and carrying out investigations, analyzing and interpreting data, using mathematics and computational thinking, and designing solutions)" (TG, page 5.5.8). However, as stated in the bullet above, one of the two elements listed on the rubric as criteria for **Using Mathematics and Computational Thinking** is above students' grade level.

Engaging in Argument from Evidence:

- *Compare and refine arguments based on an evaluation of the evidence presented.*
    - This element is claimed in the front matter (TG, page 5.0.8).
    - This element is claimed in Appendix 5.2 (TG, page 5.2.A1).
        - Lesson 2: Students do a gallery walk of peer presentations (arguments) and leave feedback (TG, pages 5.2.13–5.2.14). Students are not prompted to refine arguments at this point.
- *Construct and/or support an argument with evidence, data, and/or a model.*
    - This element is claimed in the front matter (TG, page 5.0.8).
    - This element is claimed in Appendix 5.2 (TG, page 5.2.A1).
        - Lesson 2: Students are asked to make a presentation supporting a claim, including evidence and models of their evidence (TG, page 5.2.13).
- *Respectfully provide and receive critiques from peers about a proposed procedure, explanation, or model by citing relevant evidence and posing specific questions.*
    - This element is claimed in the front matter (TG, page 5.0.8).
    - This element is claimed in Appendix 5.2 (TG, page 5.2.A1).
        - Lesson 2: Students do a gallery walk of peer presentations and leave feedback (TG, pages 5.2.13–5.2.14). The teacher is told to "facilitate the gallery walk and peer feedback" although specific guidance to students about citing relevant evidence or posing questions is not explicitly provided.
- *Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.*
    - This element is claimed in the front matter (TG, page 5.0.8).
    - This element is claimed in Appendix 5.2 (TG, page 5.2.A1).
        - Lesson 2: Students make claims about data, but do not discuss solutions to problems or criteria and constraints.

Obtaining, Evaluating, and Communicating Information:

- *Read and comprehend grade-appropriate complex text and/or other media to summarize and obtain scientific and technical ideas and describe how they are supported by evidence.*
    - This element is claimed in the front matter (TG, page 5.0.8).
    - This element is claimed in Appendix 5.2 (TG, page 5.2.A1).

        - Lesson 2: Students are supported to pull evidence out of text (TG, page 5.2.9). Although educators are directed to read aloud the text, paragraphs 7, 9, and 10 of the Analyze This text in Lesson 2 are above grade level.
    - This element is claimed in Appendix 5.4 (TG, page 5.4.A1).
        - Lesson 4: Students are supported to pull evidence out of text (TG, page 5.4.6). Although it is offered that the educator might read aloud the text in Lesson 4, the text Separating Mixtures is above grade-level.
- *Communicate scientific and/or technical information orally and or in written formats, including various forms of media as well as tables, diagrams, and charts.*
    - This element is claimed in the front matter (TG, page 5.0.8)
    - Claimed in Appendix 5.2 (TG, page 5.2.A1)
        - Lesson 2: Students are asked to make a presentation supporting a claim, including evidence and models of their evidence (TG, page 5.2.13).
    - Claimed in Appendix 5.4 (TG, page 5.4.A1)
        - Lesson 4: Students are asked to write their responses to prompts (TG, page 5.4.8).

Disciplinary Core Ideas (DCIs) | **Rating: Adequate**

The reviewers found adequate evidence that students have the opportunity to use or develop the DCIs in this unit. Students have opportunities to develop most of the claimed physical science DCI content. However, the claimed ETS DCIs are not developed or clearly used in the learning sequence; instead, students apply related SEPs.

PS1.A: Structure and Properties of Matter:

- *Matter of any type can be subdivided into particles that are too small to see, but even then, the matter still exists and can be detected by other means.*
    - This element is claimed in Appendix 5.1 (TG, page 5.1.A1).
        - Lesson 1, Part II, Engage, Step #13: Students model phenomena that may have microscopic parts, and students are prompted: "Use your model to explain how there may be other material in the water that you cannot see" (TG, page 5.1.7). Expected student responses include "they are too small to be seen." In this lesson, students do not discuss the end portion of the element (…"can be detected by other means").
    - This element is claimed in Appendix 5.2 (TG, page 5.2.A2).
        - Lesson 2, Part II, Explore 1, Step #4: "Ask student pairs to use what they know about making models to draw in their science notebook a model of what they see in the two glasses. As students draw their models, look for them to depict these ideas: a single shape that represents a water particle, particles loosely drawn in the glass to represent a liquid, parts labeled" (TG, page 5.2.5).
        - Lesson 2, Part V, Explain, Step #26: Students do investigations with matter too small to see, including starting "with a visible quantity and use dilutions to

illustrate that matter can be present even when it is no longer visible to our eye" (TG, page 5.2.11).

- This element is claimed in Appendix 5.4 (TG, page 5.4.A2).
    - Lesson 4: Students use this understanding to design a filter to remove particles too small to see from mixtures.
- This element is claimed in Appendix 5.5 (TG, page 5.5.A2).
    - Lesson 5: Students use this understanding to continue to design a filter to remove particles too small to see from mixtures and discuss how they will determine how the particles have, in fact, been removed.

- *Measurements of a variety of properties can be used to identify materials.*
    - In the learning sequence, all substances/materials (with the exception of bleach and vinegar which students are never asked to identify) are identified for students prior to students investigating or describing their properties. Students are then asked to identify materials from within the given, pre-determined materials. In Lesson 2, students are told that scientists use indicators to identify things they cannot see. Phenolphthalein is added to multiple containers of clear substances, turning the liquid bright pink, but students are not asked to identify the substance based on its property that it turns bright pink in the presence of phenolphthalein. They are simply asked to recognize that the water samples are, in fact, contaminated (Lesson 2, Step #7 and #11–#14). Note that it is vinegar or bleach that causes the reaction to phenolphthalein, but this is never clarified for students, nor are they expected to identify the bleach or vinegar additive. Students are led to believe that the color change is due to the previously identified salt or sugar. Therefore there is limited evidence that students fully develop this DCI element during the unit.
    - This element is claimed in Appendix 5.3 (TG, page 5.3.A2).
        - Lesson 3: In the lesson students identify properties that can be used to sort materials, beginning to build toward this element. In Part II, Explore 2 when students explore the property of solubility, each material used is identified for students: "There are 5 3-oz. small cups with 2 teaspoons of the item labeled on the cup" (TG, page 5.3.12).
    - This element is claimed in Appendix 5.4 (TG, page 5.4.A2).
        - Lesson 4, Part I, Explain 1, Step #7: "How does understanding properties of matter help us use filtration to identify materials?" (TG, page 5.4.8).
    - This element is claimed in Appendix 5.5 (TG, page 5.5.A2).
        - Lesson 5: Students would need to use part of this element to describe the rationale for their design solutions.
- *The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish.*
    - This element is claimed in Appendix 5.3 (TG, page 5.3.A2).
        - Lesson 3: This element is claimed. Students make observations of matter seeming to vanish while conserving weight, and the teacher is told "Students are being introduced to the new element of PS1.A: amount (weight) of matter is

conserved when it changes form, even in transitions in which it seems to vanish. Students may think the matter "disappears" or vanishes when mixed into the water, but the weight will indicate that matter is in the water; it's just not visible. This helps students grasp the meanings of solubility and dissolving" (Lesson 3, page 14).

ETS1.A: Defining and Delimiting Engineering Problems

- *Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.*
    - This element is claimed in Appendix 5.4 (TG, page 5.4.A2).
        - Lesson 4, Part II, Explore 2, Step #12: "Ask table groups to identify the criteria that must be met in order to successfully resolve the water problem. Ask groups to discuss what successfully solving the problem would look like. Ask groups to share ideas and then as a class, agree to the criteria that will be used to determine a solution to the problem. Ask students to record the agreed-upon criteria in the box labeled #2 on 5.4.H3: Environmental Engineer Design Plan" (TG, page 5.4.9).
        - Lesson 4, Part II, Explore 2, Steps #13–14: "Ask table groups to determine the limitations that are present in creating a solution to this problem. Display the materials that are available for use. (See materials list.) Provide names for items if students ask but refrain from providing details on ways to use the tools. Ask table groups to share ideas, and then as a whole class agree to the constraints that will be imposed on the design solution. Then have students write the constraints in the box labeled #3 on 5.4.H3: Environmental Engineer Design Plan" (TG, page 5.4.10).
        - Students are not guided to reflect on and discuss the importance of identifying criteria and constraints.
    - This element is claimed in Appendix 5.5 (TG, page 5.5.A2).
        - Lesson 5, Engage, Step #4: "Ask the students to review their table group's plan recorded on 5.4.H3: Environmental Engineer Design Plan to get the matter separated and identified. Now that they know the Town Water Sample is #2, does their plan still work? How will knowing the properties of the materials affect the engineer design plan? Does it still meet the criteria and constraints" (TG, page 5.5.5).
        - Lesson 5, Elaborate, Steps #21–22: "Divide the class into sample #1 and sample #3 groups and then into smaller groups of four. Have students discuss their ideas for separating their mixture. Ask them to choose the best idea. Ask groups from #1 and from #3 to share their ideas with the class, explaining which process would be the best and why" (TG, page 5.5.8). In this activity students

might use criteria and constraints to determine the best solutions (this is not prompted), but this DCI understanding is not explicit.

- Lesson 5, Explain 1, Step #12: "Have partners return to their table group. Ask them to compare their observations and results with the criteria and constraints and complete the box labeled #8 on 5.4.H3: Environmental Engineer Design Plan" (TG, page 5.5.7) "Our plan met the criteria or was efficient at __ based on these observations: __Our plan did not meet the criteria or was less efficient at __based on these observations:__" (TG 5.4.19).

ETS1.B: Developing Possible Solutions

- *At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.*
  - Although this full ETS element is claimed, it is not explicitly discussed or used as an overall concept. For example, students do not decide on their own that it is important to communicate with peers (which would be evidence that they are applying this from prior learning).
  - This element is claimed in Appendix 5.4 (TG, page 5.4.A2).
    - Lesson 4, Part II, Explain 2, Steps #19–21: "Conduct a table group feedback review of the plans (similar to a gallery walk). One group member remains at the table to present the plan to visiting classmates and receive feedback/ questions while other group members visit different groups to provide feedback on their proposed procedures. Direct students to use green sticky notes to identify where the plans are valid and to use yellow sticky notes to write probing questions where the plans need more thought. Circulate, providing feedback and asking probing questions as needed. Hand out 5.4.H5: Rubric and tell students to consider only the first two rows at this time (defining problems and developing and using models). Ask table groups to reconvene, consider their peer feedback, and use the descriptions on the rubric to modify their plan" (TG, page 5.4.12).
  - This element is claimed in Appendix 5.5 (TG, page 5.5.A2).
    - Lesson 5, Explain 2, Step #17: "Ask students to individually write in their science notebook reflecting on the different design processes created by their peers and the data showing how each design worked in separating the various matter in the water samples. Based on the comparison of different designs, ask students to write ideas or a best design solution for separating the substances and describe why they propose the plan, tools, and materials for separating the substances" (TG, page 5.5.8). This activity could help students develop toward an understanding of the last part of the element.

Crosscutting Concepts (CCCs) | **Rating: Adequate**

The reviewers found adequate evidence that students have the opportunity to use or develop the CCCs in this unit. Students have several opportunities to use and develop an understanding of the **Scale,**

Proportion, and Quantity CCC elements, but there is a significant mismatch between the claims and evidence for the other CCCs.

Patterns:

- This CCC category is claimed as being part of Lessons 2–5 in the Learning Sequence 3-Dimensional Progressions chart (TG, page 5.0.14).
- *Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rate of change for natural phenomena and designed products.*
  - This element is claimed in the front matter (TG, page 5.0.9).
  - This element is claimed in Appendix 5.2 (TG, page 5.2.A2).
    - The custom three-dimensional outcomes for two parts of Lesson 2 – Part I Engage and Part VI Elaborate – include patterns as a learning target, but there is no evidence within these activities that students are explicitly facilitated or prompted to make connections related to patterns.
      - Part I, Engage: The learning goal is stated as "Communicate information and identify patterns in the materials that are in the Town Water Samples" (TG, page 5.2.5).
      - Part VI, Elaborate: The learning goal is stated as "Evaluate and communicate information and argue from evidence (data and models) about patterns in the particles in the water" (TG, page 5.2.12).
    - Lesson 2, Part II, Explore 1, Step #13 assumes that students apply patterns related to the implications of indicators first observed in Lesson 2, Part II, Explore 1, Step #7, "Ask the other student to carefully add 3 drops of phenolphthalein into jars #3 and #4. Ask the class, 'What do you notice?' ESR: The water turned pink in jar #3, but not in jar #4. There are contaminants in jar #3, but probably not in jar #4" (TG, page 5.2.7). Students do not discuss rates of change.
  - This element is claimed in Appendix 5.3 (TG, page 5.3.A2), with the following strikethroughs: Similarities and differences in patterns can be used to sort, classify, communicate and ~~analyze simple rate of change~~ for natural phenomena ~~and designed products~~. However, the difference between the K–2 and 3–5 level element is the focus on rates of change, so removing this results in students using a K–2 level practice.
    - Lesson 3, Part I, Explore 1, Steps #16–17: "Ask students to work as a team to sort the items by their properties. On a whiteboard or chart paper, ask students to make a group record showing the items that were sorted and the property used to group them. Have teams review their sorting, asking them to compare and contrast their data to find patterns. Ask students to record their ideas in their science notebook" (TG, page 5.3.8).
    - Lesson 3, Part I, Explore 1, Step #18: "Students observe similarities and differences in the ways the different items were sorted. Guide students to look for patterns in objects that are sorted in groups. Take notice of any patterns in the way the matter was sorted focusing on the relationships of the items in each

group. Ask, 'How are the sorting groups of others similar to your sorting? How are they different?'" (TG, page 5.3.9).

- Lesson 3, Part I, Explore 1, Step #19: "In table groups, discuss patterns of both differences and similarities that were noticed in the gallery walk. Have each table group share one idea" (TG, page 5.3.9).

  - This element is claimed in Appendix 5.5 (TG, page 5.5.A2). In the lesson, students compare the features of successful designs. However, there is no evidence that students are explicitly engaging in work related to, or being prompted to connect back to patterns, specifically rates of change.

- *Identify patterns related to time, including simple rates of change and cycles and use these patterns to make predictions.*
  - This element is claimed in the front matter (TG, page 5.0.9) as a separate element of **Patterns**, but this derivative is not an NGSS element. It seems to be derived from the following element, but the derivative nature is not explicit in the document so this change may be confusing to readers: *Patterns of change can be used to make predictions.*
  - This element is claimed in Appendix 5.4 (TG, page 5.4.A2). Rates of change are not discussed in the lesson.
- *Identify similarities and differences in order to sort and classify natural objects and designed products.*
  - This element is claimed in the front matter (TG, page 5.0.9) although it is not an element from the NGSS so listing it as an element may be confusing to readers.
  - This element is claimed in Appendix 5.4 (TG, page 5.4.A2). Students use patterns to consider design solutions that include classifying and sorting matter, but rates of change are not discussed in the lesson.

Cause and Effect

- This CCC category is claimed as being part of Lesson 2 in the Learning Sequence 3-Dimensional Progressions chart (TG, page 5.0.14).
- *Cause and effect relationships are routinely identified, tested, and used to explain change.*
  - This element is claimed in the front matter (TG, page 5.0.9).
  - This element is claimed in Appendix 5.2 (TG, page 5.2.A2).
    - Lesson 2, Part II, Explore 1, Step #8, Teacher Note: A portion of the element is implied in a teacher note with the educator being told "It is important for students to consider this crosscutting concept to help them formulate questions that can be investigated" (TG, page 5.2.6). This note comes right after a note to educators regarding a K–2-level **Cause and Effect** element (*Events have causes*). This portion of the note may refer to the question generation in Lesson 2, Part V, Step #20 (TG, page 5.2.9), but this connection is not clear and the Grade 3–5 level CCC element is not discussed with or explicitly used by students during the lesson. Students identify cause and effect relationships (e.g., the effects of

dilution), but do not use the idea that these relationships are routinely identified and used.

Scale, Proportion, and Quantity:

- This CCC category is claimed as being part of Lessons 1–4 in the Learning Sequence 3-Dimensional Progressions chart (TG, page 5.0.14).
- *Natural objects and/or observable phenomena exist from the very small to the ~~immensely large or from very short to very long time periods.~~*
    - This element is claimed in the front matter (TG, page 5.0.9), including strikethroughs.
    - This element is claimed in Appendix 5.1 (TG, page 5.1.A1), including strikethroughs.
        - For Lesson 1, Handout 5.1.H1 students are asked to "Draw and describe a model of everything inside your jar from the perspective of two different scales: as you see it (macroscopic view) and as you would see it if you could shrink down to a very small scale (as you might see with a microscope)" (TG, page 5.1.12).
    - This element is claimed in Appendix 5.2 (TG, page 5.2.A2), including strikethroughs.
        - Lesson 2, Part VI, Elaborate, Step #31: "To assess students on their understanding of scale, proportion, and quantity, ask students to use a whiteboard or a piece of chart paper to draw one particle model of a glass of water coming from the drinking fountain at school B for room 215 and another particle model for the drinking fountain at school B by the door of room 200" (TG, page 5.2.12).
    - This element is claimed in Appendix 5.3 (TG, page 5.3.A2), stated as "Natural objects exist from the very small to the ~~immensely~~ large."
        - Lesson 3, Part II, Explain 2, Step #43: "Listen for how students talk about dissolving. You want them to realize that that they know it doesn't disappear, it just becomes invisible because matter is made of particles too small to be seen" (TG, page 5.3.14).
    - This element is claimed in Appendix 5.4 (TG, page 5.4.A2), including strikethroughs. In the lesson students plan a solution to separate matter that is too small to be seen from a mixture.
- *Standard units are used to measure and describe physical quantities such as weight, ~~time, temperature,~~ and volume.*
    - This element is claimed in the front matter (TG, page 5.0.9), including strikethroughs.
    - This element is claimed in Appendix 5.2 (TG, page 5.2.A2), including strikethroughs.
        - Lesson 2: Students are introduced to the idea of quantifying and describing quantities with "parts per billion" (Part V, Explain, Step #24) and measuring volume in graduated cylinders using mL (Handout 5.2.H2 TG page 5.2.20).
    - This element is claimed in Appendix 5.3 (TG, page 5.3.A2), including strikethroughs.
        - Lesson 3, Part I, Explore 1, Step #21: The educator is told "Discuss and review the labels and units (such as grams, centimeters) that would likely be recorded when scientists measure the various properties. Ask, 'Do all properties have units?' (no)" (TG, page 5.3.9).

- Lesson 3, Part I, Explore 1, Step #21, Teacher Note: "If needed, help students understand that one of the new properties, weight, will be used as they re-sort objects in the tray. When describing the term weight, do not include any discussion of mass. Instead refer to weight as the heaviness an object has compared to other objects. The purpose is to provide more concrete examples of using the CCC for Scale, Proportion, and Quantity" (TG, page 5.3.10).
- Lesson 3, Part II, Explore 2, Step #38: The teacher is told "It is important to ask probing questions about the standard units used for measuring and reporting weight; that is, in our everyday life, we measure weight in pounds; in our science work, we measure weight in grams" (TG, page 5.3.13).

Energy and Matter

- This CCC category is claimed as being part of Lesson 2 in the Learning Sequence 3-Dimensional Progressions chart (TG, page 5.0.14).
- *Matter is made of particles and that energy can be transferred in various ways and between objects.*
    - This element is claimed in the front matter (TG, page 5.0.9) as a single element of **Patterns**. However, this statement is made up of two, individual elements of **Energy and Matter**.
- *Matter is made of particles.*
    - This element is claimed in Appendix 5.2 (TG, page 5.2.A2).
        - Lesson 2: Students are expected to represent microscopic particles in their model, including to represent water as particles (e.g., Lesson 2, Part 2, Explore 1, Step #14, TG page 5.2.7).

System and System Models

- This CCC category is claimed as being part of Lesson 5 in the Learning Sequence 3-Dimensional Progressions chart (TG, page 5.0.14)
- *A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.*
    - Lesson 5, Explain 1, Step #12: Students develop their designs, and the teacher is told to say, "Please explain to me how your design system works" (TG, page 5.5.7). However, the concept of systems is not otherwise discussed so it isn't clear students use this element.

Suggestions for Improvement

Overall, consider ensuring that there is consistency in the element claims that appear in the unit introduction, the Learning Sequence three-dimensional Progressions, and the appendices of the individual lessons. For example, removing or clarifying claims of elements that are not fully used by students would provide clarity and coherence for teachers and administrators.

Science and Engineering Practices

- Consider identifying one or more select SEP elements for students to develop during the learning sequence as key targets, and focusing on providing supports for students to increase their learning in those prioritized elements.
- Consider removing above grade level element expectations from rubrics or clarifying to educators that these are expectations beyond students' grade level.

Disciplinary Core Ideas

- The description of the modeling tasks in Lesson 1 and 2 paired with the provided examples of what students might draw seems to create a discrepancy of expectations for student proficiency with PS1.A. Consider revising the example student work in Lesson 1 and early in Lesson 2 (prior to the Analyze This article) to reflect that students may not know to represent individual particles (e.g., labeling it as a pre-assessment of students' knowledge of the particulate nature of matter). Similarly, consider revising the expectations for the Lesson 2, Part II, Explore 1 task. It is unlikely that educators would need to expect students to represent individual particles in early lessons as this DCI element is called out as a learning target in later lessons.

Crosscutting Concepts

- Consider rewording the modified CCC elements to match those in the NGSS, or clearly specifying which are modifications.
- Student use of **Patterns** in the learning sequence is currently at a K–2 level (focused on identification of patterns). Consider supporting students to use a 3–5-level CCC element or clarifying that the intent of the unit is to practice the K–2 level element.
- The targeted Crosscutting Concepts are identified in both the unit front matter and the lesson level appendices. However, the use and development of the claimed CCC elements by students is not always clear in the body of the lessons. Consider opportunities to make CCC element use and development more explicit during lessons.

I.C. INTEGRATING THE THREE DIMENSIONS

Student sense-making of phenomena and/or designing of solutions requires student performances that integrate elements of the SEPs, CCCs, and DCIs.

Rating for Criterion I.C. Integrating the Three Dimensions	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that student performances integrate elements of the three dimensions in service of figuring out phenomena and designing solutions to problems. Throughout the learning sequence, students have multiple opportunities to perform at the intersection of the three dimensions and focus their work on sense-making and problem solving.

Each lesson is associated with an NGSS PE, and individual lesson sections also have their own customized three-dimensional goals. When those stated learning goals use a **Scale, Proportion, and Quantity** CCC element, they are performed by students. When those stated learning goals claim a different CCC element, student performances are generally two dimensional, only using SEPs and DCIs. See Criterion I.B for more details on CCC alignment.

Related evidence includes:

- Lesson 2, Part I, Engage, Step #1: Students are supported to connect their abstract learning directly to the real-world phenomenon. With teacher prompting, an expected student response is "I would not drink from jar #2 because it has sand in it; not sure about #3 and #4—we know from our models that there could be things in there that we can't see" (TG, page 5.2.5). In this performance, students use the following three dimensions:
    - SEP: *Use models to predict phenomena.*
    - DCI: *Matter of any type can be subdivided into particles that are too small to see, but even then, the matter still exists and can be detected by other means.*
    - CCC: *Natural objects and/or observable phenomena exist from the very small to the large.*
- Lesson 4, Part I, Explain 1: The claimed learning performance is: "Communicate information about properties of matter to make predictions based on size." Specifically, in Step #7, one of the multiple prompts asks students, "How does understanding properties of matter help us use filtration to identify materials?" (TG, page 5.4.8). In this case, evidence indicates that students use the following elements with a focus on problem solving:
    - SEP: *Communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts.*
    - DCI: *Measurements of a variety of properties can be used to identify materials.*
    - CCC: *Natural objects and/or observable phenomena exist from the very small to the large.*
- Lesson 5, Evaluate, Step #23: "Have students work in pairs to discuss what they learned from separating the mixture in Town Water Sample #2. Based on that information, they must develop an explanation that describes how a water filter works. They should include their understanding of: particle size, the properties of materials that are used to identify them, the scale of the filter, water, and contaminants" (TG, page 5.5.8). In this performance, students use the following three dimensions:
    - SEP: *Use evidence (e.g., measurements, observations, patterns) to construct of support an explanation or design a solution to a problem.*
    - DCI: *Matter of any type can be subdivided into particles that are too small to see, but even then, the matter still exists and can be detected by other means.*
    - CCC: *Natural objects and/or observable phenomena exist from the very small to the large.*

Suggestions for Improvement

Consider supporting students to fully use the claimed CCC elements; this would allow an increase in the amount of time students participate in three-dimensional learning.

I.D. UNIT COHERENCE

Lessons fit together to target a set of performance expectations.

i. Each lesson builds on prior lessons by addressing questions raised in those lessons, cultivating new questions that build on what students figured out, or cultivating new questions from related phenomena, problems, and prior student experiences.
ii. The lessons help students develop toward proficiency in a targeted set of performance expectations.

Rating for Criterion I.D. Unit Coherence	Inadequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found inadequate evidence that lessons fit together coherently to target a set of performance expectations (PEs) because although individual lessons are, in general, coherently linked together in a logical way from the students' perspective, slightly more than half of the elements within the claimed PE learning targets are not developed or used by students.

Overall, the lessons fit together logically — the topics flow well together and the entire learning sequence is focused on the same phenomenon and problem. Exceptions to this are listed below:

- Lesson 2 (Part 1, Engage, Steps #1–3) begins with students reviewing their models of the Town Water Samples from Lesson 1 to "discuss which samples they would be willing to drink and why." Instead of student attention being brought back to the Design Solutions Board at this time to identify questions already generated at the conclusion of Lesson 1 related to how they could find out if water is contaminated, they are asked anew "to think about how they could find out if jar #3 and #4 are contaminated" and record their ideas in their science notebook to support discussion. Students are then asked to record new questions they have concerning the Town Water Samples, then share those questions to discuss whether they should be added to the Design Solutions Question Board (TG, page 5.2.5).
- Lesson 2, Part III, Explore 2, Step #21: "Distribute sticky notes to the groups. Provide the prompt: 'As a result of the video and your discussion, what new questions does your group have about the Town Water Samples?' Write one question on each sticky note. Ask groups to select 2–3 questions to share with the class. Facilitate a student-driven class conversation about students' questions" (TG, page 5.2.9). Lesson 2, Part IV, Explore 3, Step #22: The lesson section

immediately following the above evidence ignores that students have just generated questions and prompts educators to focus learning using a prescribed question, "Ask, 'How much stuff is in the water? Where do you think we can find answers to this question?'" (TG, page 5.2.9).

- Lesson 2, Part VII, Evaluate, Steps #40–41: The educator is prompted to identify a question on the Class or Design Solutions Question Board, or prescribe one that will be answered in Lesson 3. A discussion is facilitated about how scientists might investigate this identified question. The educator is then directed to "Conduct a brief discussion and chart some of their ideas to use in Lesson 3: Properties of Matter" (TG, page 5.2.15). Lesson 3, Part I, Engage begins with a similar conversation, "'How can we determine what substances might be contained in items we use every day? What do you think is in cereal fortified with iron?' Ask students to share ideas with a partner, and then reconvene as a class and record their ideas on the board or chart paper" (TG, page 5.3.6) without referring back to the discussion and student ideas elicited at the end of Lesson 2.
- Lesson 3, Part II, Elaborate/Evaluate, Steps #45–46: The end of the lesson elicits student ideas that could lead into the next lesson: 'Look on the Class Question Board for a question similar to "How can we remove the contaminating matter from the water in the jars?' In table groups, ask students to discuss this question" (Lesson 3, page 15). These ideas are not explicitly referred back to in Lesson 4.
- Lesson 4, Part I, Engage, Steps #2–3: "Have students respond in their science notebook to each of these prompts: What do you notice about the water in the cups? How do you think these crystals and residue formed? What are these crystals and residue? How can these crystals and residue help us solve the problem of cleaning the contaminated water in the town water samples? What new questions do you have? After students have sufficient time to think and write in their science notebook, have them share responses with the class. Add new questions to the Design Solutions Question Board" (TG, page 5.4.5). Students added new questions to the Design Solutions Question Board at the conclusion of Lesson 3, but these questions are not returned to or leveraged for the beginning of Lesson 4. Also, instead of students generating questions first about the crystalized samples, the educator is prompted to give prescribed questions for students to answer. Then students are asked to generate new questions.
- Lesson 5, Engage: This lesson begins by giving students prompts such as "what properties of matter might you use for your design?" and "To help you in your design, you can review some of possible contaminants." "Ask partners to use a whiteboard to draw their 'plan of action.' What will they do first? What materials will they use and why?" (TG, pages 5.5.5–5.5.6). These prompts may seem confusing to students who just spent Lesson 4 making their designs.

NGSS PEs are identified as targeted learning goals with the statement included in the introduction that the unit builds toward the identified PEs (TG, page 5.0.6). Although strikethroughs are used in the front matter and lesson appendices to eliminate specified portions of elements of the three dimensions (no strikethroughs are used on the identified PEs), it is unclear when students would be expected to be able to fully perform the targeted PEs, such as in a future unit. Currently, there isn't evidence within this unit that students would have opportunities to fully meet the PEs or the specified portions of the three-dimensions by the end of the unit. Overall, a little less than half of the elements required for these PEs are used or developed in the learning sequence:

- 5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating and cooling, or mixing substances, the total weight of matter is conserved. Students do not graph, nor are they engaged in learning about heating and cooling substances.
- 5-PS1-3. Make observations and measurements to identify materials based on their properties. See Criterion I.B for evidence related to the DCI in this PE; it is only used in a limited way.
- 3-5-ETS1-1. Define a simple design problem reflecting a need or want that includes specified criteria for success and constraints on materials, time, or cost. Students are told the problem and what they will be designing to solve the problem, and do not use the related DCI in this learning sequence.
- 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of a problem. Student groups only generate one design; they compare designs and discuss improvements, but do not improve or create a second iteration. They also do not use the related DCI in this learning sequence.
- The Lesson 2 Appendix claims that the lesson is building toward 5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen (TG, page 5.2.A1). This PE is not claimed in the front matter and the expectation through student work samples is for students to have already come to Lessons 1 and 2 with the knowledge and ability to depict water and other substances as particles. This means students are not working toward this PE in this lesson, they are expected to have already met proficiency with this PE in order to complete the lesson.

Suggestions for Improvement

- At the beginning of each lesson, consider referring specifically to where students ended in their tasks from the previous lessons (such as the questions they decided they wanted to answer, the investigations they decided to conduct, or the design plans they just made) and connecting that prior work explicitly to the next steps in the new lesson.
- In the beginning of Lesson 5, consider clarifying student prompts to ensure they describe "revising" design plans to acknowledge the work students did in the prior lesson.
- Consider aligning claims and evidence related to PE targets. Clarifying which PEs are fully built during the unit versus only partially built toward would make the PE claims more accurate.

I.E. MULTIPLE SCIENCE DOMAINS

When appropriate, links are made across the science domains of life science, physical science and Earth and space science.

i. Disciplinary core ideas from different disciplines are used together to explain phenomena.

ii. The usefulness of crosscutting concepts to make sense of phenomena or design solutions to problems across science domains is highlighted.

Rating for Criterion I.E. Multiple Science Domains	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that links are made across the science domains when appropriate. The anchor phenomenon and problem can be addressed within the claimed physical science domain. However, crosscutting concepts are not used explicitly across scientific domains.

A limited number of connections to other disciplines are made for the educators, but not students. For example:

- Lesson 3, Part I, Explain 1, Step #25, Teacher Note: "In addition to these physical science uses of magnetism, there are also life science connections to the use of magnetism. Magnetism is used by several species to help with navigation (birds and tiger sharks)" (TG, page 5.3.11).
- Lesson 4, Part I, Engage, Step #3, Teacher Note: "Water protection and preservation are not addressed in this learning sequence, but it can be added as an extension or differentiation strategy at the end of the sequence; it addresses 5-ESS3-1" (TG, page 5.4.5).
- Content related to core ideas of the Earth sciences domain is used but not claimed. There is no evidence that students will make connections between ideas from physical (matter) and Earth and space sciences (human impacts on Earth Systems) and use these ideas together to explain a phenomenon or problem.

The unit materials do not contain evidence that CCCs are leveraged to make connections across science domains.

Suggestions for Improvement

- Consider ensuring that relevant cross-disciplinary connections are explicit for students such that they can see how their DCI learning in one science domain relates to their sense-making in other domains.
- Consider integrating explicit connections to **ESS2.C: The Roles of Water in Earth's Surface Processes** and **ESS3.C: Human Impacts on Earth Systems**, or identifying that learning related to these Earth and space science DCIs is a prerequisite for this learning sequence.

- Consider supporting student use of CCC elements and their understanding of the utility of CCC elements to help explain phenomena related to different domains. For example, students could be supported to connect their understanding of cause and effect relationships in a human activity-related phenomenon (Earth science) to cause and effect relationships in a conservation of matter-related phenomenon (physical science).

I.F. MATH AND ELA

Provides grade-appropriate connection(s) to the Common Core State Standards in Mathematics and/or English Language Arts & Literacy in History/Social Studies, Science and Technical Subjects.

Rating for Criterion I.F. Math and ELA	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials provide grade-appropriate connections to the Common Core State Standards (CCSS) in mathematics and English language arts (ELA) because lesson materials recognize connections between science and other disciplines, and some of those opportunities directly connect literacy and mathematics skills to student science inquiry and problem solving. However, some noticeable connections are missing.

CCSS in ELA are explicitly claimed for each lesson. Throughout the unit students are asked to write, read, speak, and listen in order to collect and communicate scientific information. Related evidence includes:

- Lesson 1, Part I, Engage, Steps #3–4: "Connect to student experiences by asking them to respond to the following prompt in their science notebook: 'Think of a time when you wondered if some water was safe to drink. What made you have concerns?' Give students 3 minutes to write in their science notebook. Walk around and encourage students to expand on their writing. Ask students to share their response with their table group and then have a representative from several groups share with the whole class" (TG, page 5.1.4).
- Lesson 2, Part V, Explain, Teacher Note: "ELA connection: There are several picture books that can be used to help students understand the concept of very large numbers. These include…" (TG, page 5.2.11).
- Lesson 2, Part IV, Explore 3, Step #23: "Using the student-generated ideas of asking experts or using published materials on possible water contamination to find answers to their questions, provide students with a copy of 5.2.H1: Analyze This. Read it together as a class. Direct students to underline the evidence in the article that suggests that matter that is too small to be seen can be detected by other means" (TG, page 5.2.9).
- Lesson 3, Appendix 5.3, Common Core State Standards, CCSS ELA Speaking and Listening: CCSS.ELA-LITERACY.SL5.1 **"**Engage effectively in a range of collaborative discussions (one-on-

one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly" is claimed (TG, page 5.3.A2).

- Lesson 4, Part I, Engage, Steps #2–3: "Have students respond in their science notebook to each of these prompts: What do you notice about the water in the cups? How do you think these crystals and residue formed? What are these crystals and residue? How can these crystals and residue help us solve the problem of cleaning the contaminated water in the town water samples? What new questions do you have? After students have sufficient time to think and write in their science notebook, have them share responses with the class. Add new questions to the Design Solutions Question Board" (TG, page 5.4.5).
- Lesson 4, Part I, Explore 1, Step #4: "Tell students, 'Today, we are going to read about some ways to separate different types of matter that are mixed together. This may be helpful in answering some of your questions and provide more ideas for separating the 'stuff' in the town water samples and ultimately cleaning the sewage water. As we read, draw a star by examples of mixtures that are separated in the real world. Draw a circle around the names of the processes used to separate mixtures. Underline definitions.' Hand out 5.4.H1: Separating Mixtures. Read aloud or have pairs do a shared reading. Discuss the processes of filtration and evaporation in the article and address how the new information could be helpful in developing the plan to clean the water in the jars" (TG, page 5.4.6). In this case, students are facilitated to see how this reading helps them with their problem solving.
- Lesson 4, Part I, Explore 1, Step #5: "Challenge students to identify the difference between the processes of filtration and evaporation by revisiting the definitions in the text. Come to a class consensus on the differences. Encourage students to find evidence in the reading that focuses on the properties of matter that are important in both processes and reference exactly where the information is found in the text" (TG, page 5.4.6).
- Lesson 4, Toolbox 5.4, Handout, Separating Mixtures: The article provided is above grade-level based on Lexile reading level. (TG, page 5.4.15).
- Lesson 5, Explain 1, Steps #15–16: "Allow students to select the question they want to work on from either question board, and provide time for students to research how they might answer that question. After they have recorded their ideas in their science notebook, have them assemble in groups (based on those who worked with the same question) to share their ideas. Ask each group to make a brief presentation of their findings to the whole class" (TG, page 5.5.7 PDF page 116).
- Lesson 5, Explain 2, Steps #17–18: "Ask students to individually write in their science notebook reflecting on the different design processes created by their peers and the data showing how each design worked in separating the various matter in the water samples. Based on the comparison of different designs, ask students to write ideas for a best design solution for separating the substances and describe why they propose the plan, tools, and materials for separating the substances. Students share ideas as a class and add evidence to the Class Question Board and Design Solutions Question Board" (TG, page 5.5.8).
- Lesson 5, Evaluate, Step #24: "Have each pair make a poster to display outside the classroom, so that others can understand how a water filter works. Hang the posters around the school to make other students aware that contaminated water can be cleaned" (TG, page 5.5.9).

Mathematics connections are made, but some CCSS mathematics connections are not acknowledged by Appendix lists (e.g., 5.NBT.A.2 is not listed); only standards for mathematical practices are listed. Related evidence includes:

- Lesson 1, Appendix 5.1, Common Core State Standards, Mathematics Practices: MP.2 Reason abstractly and quantitatively is claimed as the CCSS for mathematics connection (TG, page 5.1.A2) but students are not asked or supported to reason abstractly or quantitatively in relation to mathematics during Lesson 1.
- Lesson 2, Appendix 5.2, Common Core State Standards, Mathematics Practices: MP.2 Reason abstractly and quantitatively is claimed as the CCSS for Mathematics connection (TG, page 5.2.A3).
- Lesson 2, Part V, Explain, Step #24: "After reading 5.2.H1: Analyze This bring the class's attention to the quantity 15 parts per billion which appears in the third paragraph. Have students discuss with a partner what they think parts per billion means and if they can think of a real-world example of one part of something per billion total parts. Use examples from the Teacher Note below to prompt their thinking. Ask students to identify the two materials that are compared in the article (amount of lead is compared to the amount of water)" (TG, page 5.2.10).
- Lesson 2, Part V, Explain, Teacher Note: "Differentiation strategy and/or math lesson connection. Write out the number 15. Then underneath it write the number 1,000,000,000 and address place value" (TG, page 5.2.11).
- Lesson 2, Part V, Explain, Steps 27–28: Students are not explicitly asked to reason mathematically about how the dilution investigation connects to or represents parts per billion, so as to clear up any misconceptions about ppb. However, students do "… share their results with two other groups, comparing and contrasting their models…They now know about parts per billion. Ask pairs to discuss how this information can be added to their model" (TG, page 5.2.12).
- Lesson 2, Part VI, Elaborate, Step #30: Students are asked to "review the data charts at the end 5.2.H1: Analyze This" but there is no guidance for the educator on what about the data should be reviewed or how students should be reviewing at this time. (TG, page 5.2.12).
- Lesson 2, Part VI, Elaborate, Step #31: "Have students return to 5.2.H1: Analyze This and review the data for School B only. To assess students on their understanding of scale, proportion, and quantity, ask students to use a whiteboard or a piece of chart paper to draw one particle model of a glass of water coming from the drinking fountain at school B for room 215 and another particle model for the drinking fountain at school B by the door of room 200. Tell students this model does not need to be accurate (they do not need to draw a billion dots), but it should indicate their understanding of the differences by showing room 215 fountain has 2 parts in the same volume that room 200 has in 24 parts (or 1 part for room 215 to 12 parts for room 200)" (TG, page 5.2.12).
- Lesson 4, Appendix 5.4, Common Core State Standards, Mathematics Practices: MP.2 "Reason abstractly and quantitatively," as well as MP.5 "Use appropriate tools strategically" are claimed as the CCSS for Mathematics connections (TG, page 5.4.A3).
- Lesson 4, Part II, Explore 2, Step #17: "Ask, 'How can we use math to help describe and measure this scale of filtration?' Facilitate a class discussion on the importance of conducting multiple

trials to validate results" This reference to mathematics seems like a missed connection, as the phrase "*this* scale of filtration" is not clarified. The provided expected student responses (ESRs) are assumed to be the exemplar but those provided do not include an explicit connection between filtration and mathematics, specifically how the amounts of water relate to the degree to which (scale) the water is filtered, "ESR: We can collect data on the amount of water going into the filter and how much is coming out. We can compare the color before and after the filtration process. We can repeat our process multiple times" (TG, page 5.4.11).

Suggestions for Improvement

- Consider adding a connection to 5.NBT.A.2 in Lesson 2 when students discuss expressing parts per billion.
- Consider providing guidance to teachers about the limits of mathematical expectations for students in Grade 5 such as that reasoning about ratios is not expected. This could help ensure that discussions of different parts per billion comparisons do not go beyond the grade level mathematics expectations.
- Consider how the suggested discussion prompts from Lesson 2, Part VI, Elaborate, Step #32 could be revised to focus students more on using the quantitative data from the bar graphs to inform and support their responses.
- Consider including a variety of reading formats from which students can gather scientific information. In addition to the article already included, consider how students could use infographics, news posts, and online sources to further use reading skills to develop understanding and explanations of the scientific concepts.

OVERALL CATEGORY I SCORE: 2 (0, 1, 2, 3)	
Unit Scoring Guide – Category I	
Criteria A-F	
3	At least adequate evidence for all of the unit criteria in the category; extensive evidence for criteria A–C
2	At least some evidence for all unit criteria in Category I (A–F); adequate evidence for criteria A–C
1	Adequate evidence for some criteria in Category I, but inadequate/no evidence for at least one criterion A–C
0	Inadequate (or no) evidence to meet any criteria in Category I (A–F)

CATEGORY II

NGSS INSTRUCTIONAL SUPPORTS

II.A. RELEVANCE AND AUTHENTICITY

II.B. STUDENT IDEAS

II.C. BUILDING PROGRESSIONS

II.D. SCIENTIFIC ACCURACY

II.E. DIFFERENTIATED INSTRUCTION

II.F. TEACHER SUPPORT FOR UNIT COHERENCE

II.G. SCAFFOLDED DIFFERENTIATION OVER TIME

II.A. RELEVANCE AND AUTHENTICITY

Engages students in authentic and meaningful scenarios that reflect the practice of science and engineering as experienced in the real world.

i. Students experience phenomena or design problems as directly as possible (firsthand or through media representations).

ii. Includes suggestions for how to connect instruction to the students' home, neighborhood, community and/or culture as appropriate.

iii. Provides opportunities for students to connect their explanation of a phenomenon and/or their design solution to a problem to questions from their own experience.

Rating for Criterion II.A. Relevance and Authenticity	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials engage students in authentic and meaningful scenarios that reflect the real world because clean water access issues are relevant to many communities for a variety of reasons, so students are likely to relate and easily comprehend why the issue is important to many people. However, the design challenge that drives most of the learning sequence is contrived. It's likely that students will realize it is not real and will likely feel that the need to solve the problem comes purely from the teacher.

Evidence related to the authenticity of the design challenge includes:

- Lesson 1, Part II, Engage, Step #7: "Introduce the problem: There is a town that is concerned about its local water sources. Many believe that the sources have been contaminated. The town has hired you and your fellow environmental engineers to design a solution to remove the contaminants from the water" (TG, page 5.1.5). The majority of Grade 5 students will be well aware that they have not actually been hired for this task. This contrived scenario is unlikely to encourage student engagement with the problem.
- Lesson 1, Part II, Engage, Step #12: "Make an announcement: 'The police have surveyed the area where they think the contamination might have occurred. They found empty bags of sugar, salt, iron filings, and sand near the town's water sources. This could be evidence of tampering with the water.' Ask students how this announcement might affect their observations and models. Have students add to or refine their models using a different-colored pencil" (TG, page 5.1.6). The contrived nature of this scenario may allow educators to deliver instruction within the constraints of the classroom, but students are likely to realize it is inauthentic. This is an oversimplification of a very real problem that many communities face. Students will likely question why it is a concern that sugar and salt would be a dangerous problem in water.

- Lesson 4, Part II, Explore 2, Step #10: "Remind the class that they have been hired as environmental engineers to solve a problem" (TG, page 5.4.9). Again, it will be obvious to Grade 5 students that they have not been hired, so this strategy is not likely to increase motivation or define a sense of purpose.

Students experience the identified anchor phenomenon as directly as possible, through media representation, and they have many opportunities to connect the phenomenon and problem to their prior experiences, community, or culture. Students have multiple opportunities to generate their own questions, but educator support is not explicitly provided to cultivate questions related to student experiences, homes, neighborhoods, communities, or cultures. Related evidence includes:

- Lesson 1, Part I, Engage, Step #1: Students experience the identified anchor phenomenon "Sewage water is consumed by people, but they do not get sick" by watching and asking questions about the video "Drinking Filtered Sewage Water" (TG, page 5.1.4).
- Lesson 1, Part I, Engage, Step #5: "Have students think about the local water supply chain: 'Where does the local water come from? How might the local water become contaminated? How can we prevent that from happening? How can we fix it? How can we make sure we don't have contaminated water?' Ask students to write their ideas in their science notebook and then share with a partner. Ask a few partners to share. Share this prompt: I wonder if we can think about how we could make sure we don't have contaminated water?" (TG, page 5.1.4).
- Lesson 2, Part III, Explore 2, Step #16, Teacher Note: "If it's necessary to provide greater student engagement, find a news clip or news article on water contamination for a local area with which students are familiar" (TG, page 5.2.8).
- Lesson 2, Part III, Explore 2, Step #19: "Next, ask table groups to focus on these two questions: 'What experiences have you had related to poor water quality?' 'How might water contamination affect California (or your location) on a large scale?'" (TG, page 5.2.9).
- Lesson 2, Part IV, Explore 3, Step #23, Teacher Note: "Alternatively, if local water district data and reports are available for your location, substitute local data for 5.2.H1: Analyze This in order to elicit greater student interest. Another option would be to invite a water district guest speaker to present the data to your students" (TG, page 5.2.10).
- Lesson 2, Part V, Explain, Step #25: "Connect the reading with the next demonstration of how contaminants can become invisible in the water. Ask students they have ever diluted anything—what was their experience? For example, have they ever made orange juice from a can? What did they do to make the orange juice from the concentrate?" (TG, page 5.2.11).

Suggestions for Improvement

- Overall, since the identified problem is somewhat contrived, it may not serve to engage students. The reviewers recognize the sometimes difficult balance between presenting an engaging and realistic problem and working within the constraints of the classroom; no one expects that elementary students should be handling real sewage water or be expected to design the complex filters that would safely purify that sewage water. However, the majority of Grade 5 students are likely able to recognize and comprehend the utility of simulation, as well as to apply simulated scenarios to real-world applications. Consider:

  - removal of wording that may signal that the situation isn't real (e.g., "the town has hired you"),
  - highlighting for students how this learning sequence serves as a simulation of a real-world system that isn't safe to study directly, and
  - support for students in making comparisons between the simulation and real-world applications. For example, the materials could emphasize that access to clean water is a serious problem for many communities, and that scientists and engineers are working to help relieve that stress. Students could research the variety of ways that professional scientists and engineers address water access issues, be facilitated to discuss the constraints of the classroom in simulating these real-world efforts and help to decide which avenue may be the most realistic to model in the classroom (i.e., filtering). Throughout the learning sequence, students could be reminded of the real-world importance of simulating a solution to the problem. Calling it what it is and recognizing explicitly that students are not creating effective filters for actual contaminated water could be a valuable opportunity to engage students in the SEP element of *identifying limitations of models*, as well as in discussions about constraints. Finally, students could be supported to compare their filter designs to real-world filters.
- Consider including guidance that makes clear to educators a need to caution students that filters created during instruction will not properly and fully filter sewage water, or water with other contaminants.
- In consideration of families and communities that may be suffering with serious clean water access issues, consider including language or resources to equip educators with what they need to approach this unit with appropriate sensitivity.
- Consider including a suggestion for educators to identify and display images or maps of important public water infrastructure in the school community (e.g., water towers, reservoirs, waste water treatment facilities, pumping stations).
- The suggestion in Lesson 2, Part IV, Explore 3, Step #23, Teacher Note to replace the 5.2.H1: Analyze This article with local water district data and reports or a water district guest speaker (TG, page 5.2.10) without clear guidance on what specifically educators should look for could lead to misalignment with the remainder of the lesson (e.g., educators might substitute another resource for the article that doesn't include the discussion of parts per billion). When suggesting that educators can identify and use alternatives, consider either including some minimal criteria for those alternatives so that educators are guided towards resources aligned to the intent of the lesson, or noting for educators the changes to the learning sequence that might occur if certain criteria are omitted.

II.B. STUDENT IDEAS

Provides opportunities for students to express, clarify, justify, interpret, and represent their ideas and respond to peer and teacher feedback orally and/or in written form as appropriate.

Rating for Criterion II.B. Student Ideas	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials provide students with opportunities to both share their ideas and thinking and respond to feedback on their ideas because students have many opportunities to represent and justify their ideas and a few opportunities to respond to peer and teacher feedback.

Students are asked to describe and justify their ideas throughout the learning sequence. For example:

- Lesson 1, Part II, Engage, Step #13: "After students have recorded their observations and developed their models, ask them to share their ideas with their table group. What do you notice in the different models? What do some of the models have in common? How are the parts of the model that are observable represented? How are the parts of the model that are not observable represented? Which jars have sugar or salt in them? Why do you think that? Do you know for sure?" (TG, page 5.1.).
- Lesson 2, Part I, Engage, Step #1: "As a table group, ask students to review their models of the Town Water Samples from Lesson 1. Ask them to discuss which samples they would be willing to drink and why. Conduct a class discussion about their reasoning" (TG, page 5.2.5).
- Lesson 2, Part III, Explore 2, Step #17: "At the end of the video clip, ask students to talk with their table groups using these prompts: 'What are you thinking about after viewing this video?' … 'Does watching this clip change your thinking about what's in jar #3 or #4?'" (TG, page 5.2.8).
- Lesson 2, Part VI, Elaborate, Step #32: "Now have students work with a partner to analyze and interpret all of the school graphs. The following prompts can be provided to guide student analysis of the data: Is the water clean at these schools? (Is there other matter in the water?) How do you know?" (TG, page 5.2.13).
- Lesson 3, Part I, Explore 1, Steps #15–17: "Distribute the prepared tray of items to each group, and pose this question: 'Looking at these items, what similarities and differences in their properties can be identified in order to sort and classify them?' Ask students to work as a team to sort the items by their properties. On a whiteboard or chart paper, ask students to make a group record showing the items that were sorted and the property used to group them. Have teams review their sorting, asking them to compare and contrast their data to find patterns. Ask students to record their ideas in their science notebook" (TG, page 5.3.8). This instructional sequence engages students in collaborative reasoning, as well as comparison among the work of several groups.
- Lesson 4, Part II, Explore 2, Step #18: "Ask table groups to make a prediction stating why their plan will work. They should explain why each part of their plan will work to separate substances

from the water. Students should justify the order of their steps in terms of why they think it will allow for the separation of each substance" (TG, page 5.4.11).

- Lesson 4, Toolbox 5.4, Handout, Environmental Engineer Design Plan: "Compare your observations and results with those of another group. Which plan or parts of your plan worked more efficiently? Which parts did not work well? Our plan met the criteria or was efficient at ____based on these observations" (TG, page 5.4.19). Students are not directed with this handout to improve or change their plan, but in Lesson 5, Explain 1, Step #12 evidence below, students are asked at the time of completing this portion of the handout "What might be a better material to use?" (TG, page 5.5.7).
- Students are asked in Lesson 5, Engage, Step #5 to discuss with a partner ideas they have about changing or refining their Environmental Engineer Design Plan and educators are reminded in Lesson 5, Engage, Step #6 to "Facilitate student discussion and push students to 'Ask questions to clarify and/or refine ~~a model, an explanation, or an~~ engineering problem'" (TG, page 5.5.6).
- Lesson 5, Explain 1, Steps #12–13: "Have partners return to their table group. Ask them to compare their observations and results with the criteria and constraints and complete the box labeled #8 on 5.4.H3: Environmental Engineer Design Plan (see Toolbox 5.4 Handout evidence above). Post these questions on a doc camera to help them with their discussion: Why did you use this particular material? How did it work? What is your data? What might be a better material to use? Please explain to me how your design system works. Have a whole-class discussion of these questions" (TG, page 5.5.7).

Students have opportunities to give and receive peer feedback and to receive teacher feedback:

- Lesson 1, Part II, Engage, Step #13, Teacher Note: "After the lesson, collect 5.1.H1: Town Water Samples as a formative assessment to gather information to direct future lessons and provide students with feedback on the expectations for drawing a model. Assess students' application of PS1.A to see if they can use prior knowledge about the particulate nature of matter" (TG, page 5.1.8).
- Lesson 2, Part VI, Elaborate, Step #34: "After student pairs have completed their posters, do a gallery walk. Provide students with sticky notes to record feedback on the posters. Facilitate the gallery walk and peer feedback" (TG, page PDF page 44).
- Lesson 3, Part I, Explain 1, Step #23: "Circulate while student teams discuss and describe how they sorted the items and their reasons or sorting the items the way they did. Based on your assessment of student discussions during the team sorts, provide feedback to the class. You might need to explain the new properties including weight (the heaviness an object has compared to other objects) and magnetism (the ability of some metal objects to be attracted to a magnetic force)" (TG, page 5.3.10).
- Lesson 4, Part 1, Explain 1, Step #9: "Provide feedback to 5.4.H2: Exit Ticket responses and return responses to students by Step 15" (TG, page 5.4.10).
- Lesson 4, Part 2, Explore 2, Step #15: "Students review their exit slip responses and feedback from Step 7 and discuss with their group this prompt: 'Thinking about your lesson experiences, what are some ways that your group can solve this problem and use properties of matter to

first separate and then identify the matter?' Have them record the scientific information they know in the box labeled #4 on 5.4.H3: Environmental Engineer Design Plan" (TG, page 5.4.10).

- Lesson 4, Part II, Explain 2, Steps #19–21: "Conduct a table group feedback review of the plans (similar to a gallery walk). One group member remains at the table to present the plan to visiting classmates and receive feedback/questions while other group members visit different groups to provide feedback on their proposed procedures. Direct students to use green sticky notes to identify where the plans are valid and to use yellow sticky notes to write probing questions where the plans need more thought. Circulate, providing feedback and asking probing questions as needed. Hand out 5.4.H5: Rubric and tell students to consider only the first two rows at this time (defining problems and developing and using models). Ask table groups to reconvene, consider their peer feedback, and use the descriptions on the rubric to modify their plan" (TG, page 5.4.12).

Suggestions for Improvement

- Consider providing guidance or suggestions to teachers about the content and format of feedback the teacher is asked to give to students, such as in Lesson 4, page 12.
- In addition to linking the Talk Primer as a resource, consider enhancing educator guidance throughout lesson directions for eliciting ideas from all students and facilitating the communication of student reasoning.
- Consider how student artifacts or the Class and Design Solutions Question Boards could be revised to engage students in iterative thinking so that they elaborate on or revise their thinking explicitly over time.

II.C. BUILDING PROGRESSIONS

Identifies and builds on students' prior learning in all three dimensions, including providing the following support to teachers:

i. Explicitly identifying prior student learning expected for all three dimensions

ii. Clearly explaining how the prior learning will be built upon.

Rating for Criterion II.C. Building Progressions	Inadequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found inadequate evidence that the materials identify and build on students' prior learning in all three dimensions because the unit materials do not comprehensively identify what learning students are expected to come in with for all three dimensions or explain how this learning will be built upon during the unit.

The way students learn or apply each of the three dimensions throughout each lesson in the learning sequence is described in detail in the Introductory document (TG, pages 5.0.12–5.0.15). The DCI progression section describes students learning, but the SEP and CCC sections do not explicitly indicate specific learning steps — they could be interpreted as applying different parts of their prior learning in different lessons. Similarly, the Conceptual Flow chart indicates a specific DCI learning flow at the element level but SEPs and CCCs are only referred to at the category level (TG, page 5.0.16).

There are references to expected prior knowledge or experiences included in some activities, but unit materials do not regularly and consistently provide explicit and comprehensive support for identifying individual students' prior learning related to the targeted three dimensions and accommodating different entry points. Related evidence includes:

- Lesson 1, Part VII, Evaluate, Step #40: "'Now that you know a clear glass of water can still be contaminated, how could a scientist investigate the types of matter in the Town Water Sample jars in order to determine all the contents in each jar? Be sure to consider the steps and requirements that scientists need to address in order to make sure the results are reliable'" (TG, page 5.2.15). There is no information to support educators in knowing what to expect and not expect students to know about planning investigations.
- Lesson 3, Part I, Engage, Teacher Note: "Students will review their prior knowledge of the basic properties of matter from second grade. Then they will build on that understanding to address the 5th-grade DCI properties of elements such as magnetism, conductivity (electrical and thermal), reflectivity, solubility, and measurement to identify unknown matter" (TG, page 5.3.6).
- Lesson 3, Part I, Explore 1, Step #14, Teacher Note: "Fifth-grade students should have prior experience with electrical circuits, conductors, and insulators. If they don't have this background knowledge, introduce it to them. You could hold up a tester and ask students what they know

about it and then build from there. Ask if anyone knows how to use the tester and build on the responses. If no one has knowledge of that, show students how to use the tester by placing an object between and touching the two open wires to see if the bulb lights" (TG, page 5.3.8).

- Lesson 3, Part I, Explore 1, Step #15, Teacher Note: "If you ask students to write, rather than talk about their responses to the question, you can assess prior knowledge of the properties of matter that were taught in second grade. Student misconceptions regarding magnetism can also be assessed at this point" (TG, page5.3.8).
- Lesson 3, Part I, Explore 1, Step #17, Teacher Note: "DCI Support: Starting in second grade, students learned materials could be classified by observable properties. In third grade, students learned that magnetism is a force that causes objects to be pushed or pulled. In fifth grade, they understand how this force can be used to identify the properties of matter" (TG, page 5.3.9).
- Lesson 3, Part I, Explore 1, Step #17, Teacher Note: "CCC Support: In grades K–2, students developed an understanding that patterns in the natural and human-designed world can be observed. In grades 3–5, this shifts to an understanding that similarities and differences in patterns can be used to sort for designated properties" (TG, page 5.3.9). The description of how this CCC progresses during the 3–5 grade band is not fully aligned to the NGSS.
- Lesson 3, Part I, Explain 1, Step #24, Teacher Note: "In third grade, students learned that magnetism is a force that causes objects to be pushed or pulled. In fifth grade, they understand how this force can be used to identify properties of matter" (TG, page 5.3.10).
- Lesson 3, Part II, Explore 2, Step #30, Teacher Note: "This is the students' first exposure to the property of solubility. The purpose of your questions is to elicit student's background knowledge. Hopefully from the questions that students have asked, one relates to mixing. If not, ask the question: 'What would be an important property of matter when making lemonade with fresh lemons? If you want your lemonade sweet, what might you do?' ESR: Add sugar. Ask, 'What must the sugar do to make the lemonade sweet?' ESR: Dissolve in the lemon juice. Ask, 'What does dissolve mean?' Have students discuss with a partner" (TG, page 5.3.12).
- Lesson 3, Part II, Explain 2, Step #41, Teacher Note: "Students are being introduced to the new element of PS1.A: amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. Students may think the matter 'disappears' or vanishes when mixed into the water, but the weight will indicate that matter is in the water; it's just not visible. This helps students grasp the meanings of solubility and dissolving" (TG, page 5.3.14).
- Lesson 4, Part II, Explain 2, Teacher Note: "By the end of grade 5, students are expected to have the skill to 'respectfully provide and receive critiques from peers about a proposed procedure, explanation, or model by citing relevant evidence and posing specific questions'" (TG, page 5.4.11).
- Although this is a Grade 5 unit, so students will likely have encountered the ETS DCIs previously, no prior student knowledge is explicitly built upon for these DCIs.
- Unit- or lesson-level map(s) or description(s) of learning progression for each targeted element of all three dimensions are not provided to educators; educators are unable to see the expected path of student growth from their prior understanding to the learning outcomes for each element.

Although some DCI-related learning progressions are described, one of the DCI-related learning goals for PS1.A seem to be expected as prior learning, so students may not be supported to learn these goals. Related evidence includes:

- Introduction and Lesson 1: "In order to do this throughout the learning sequence, students will build on their prior knowledge that matter is made of particles too small to be seen, but even then, the matter still exists and can be detected by other means" (TG, pages 5.0.10 and 5.1.2). It is unclear when students would have already reached full proficiency with 5-PS1-1, since this is also a learning goal for the unit and PS1.A addressed previously (through Grade 2 in the NGSS) would not have equipped students with the full understanding of particles, just that the same set of small pieces can be used to create or can make up several different objects or shapes.
- Lesson 1, Part II, Engage, Step #13, Teacher Note: "Assess students' application of PS1.A to see if they can use prior knowledge about the particulate nature of matter" (TG, page 5.1.8). The expectation for student proficiency with PS1.A related to the particulate nature of matter and consequently 5-PS1-1 is unclear, as the examples of what students might draw provided in the lesson materials include particle representation, but there is no explanation of when students would have worked with 5-PS1-1 previously, and this DCI is claimed as a learning goal in the unit.

Suggestions for Improvement

- Consider clarifying the prior knowledge expectations for students related to the particle model of matter and the claimed ETS DCIs. If they are prior knowledge, then they could be removed from the learning goal list. If they are meant as learning goals, scaffolding for learning could be added.
- To fully meet this criterion, consider identifying (at the element level) what prior knowledge students are expected to build on for all three dimensions and then explaining how this learning will be added to throughout the unit. In particular, consider explicitly describing the CCC and SEP understandings that students are expected to have prior to this unit, as well as how students will build on those understandings during this unit.

II.D. SCIENTIFIC ACCURACY

Uses scientifically accurate and grade-appropriate scientific information, phenomena, and representations to support students' three-dimensional learning.

Rating for Criterion II.D. Scientific Accuracy	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials use scientifically accurate and grade appropriate scientific information because a significant majority of information in the learning sequence is scientifically accurate.

Only two instances of possibly misleading contexts were found:

- Lesson 2, Part II, Explore 1, Steps #11–14: "Ask students what they might do to see if there are any unobservable contaminants in the Town Water Samples ESR: We could use an indicator. Have two students help with a demonstration for the whole class. One student will carefully add 3 drops of phenolphthalein into jars #1 and #2. Ask the class, 'What do you notice?' ESR: The water turned pink meaning there is something in jar #1 besides the black things and something in jar #2 besides the sand. Ask the other student to carefully add 3 drops of phenolphthalein into jars #3 and #4. Ask the class, 'What do you notice?' ESR: The water turned pink in jar #3 but not in jar #4. There are contaminants in jar #3, but probably not in jar #4. Ask the class to identify what the contaminants might be. ESR: Perhaps sugar or salt. It could be both or only one; we don't know for sure. Ask students, based on this new information, to revise their models from Lesson 1; Town Water Samples (Step 1 in this lesson) and share with their table group" (TG, page 5.2.7). Then, again, in Lesson 3, Part II, Explore 2, Step #32 students reference the phenolphthalein reaction, "But we know from using the indicators that there are other particles we can't see in jars #1, #2, and #3. We think these particles have dissolved." (TG, page 5.3.12). The bleach or vinegar is added to certain water samples in order to force a reaction to the phenolphthalein. However, neither bleach nor vinegar are mentioned to students, and students are not expected to identify the bleach or vinegar, so they are led to believe that the previously identified sugar or salt in the water samples may be causing the color change. Sugar and salt would not result in an observable color change when in the presence of phenolphthalein.
- As there is currently no educator guidance or directions to the contrary, students might develop the misconception that filters made from household materials would fully purify contaminated water.

The educator is supported with grade-appropriate conceptual understanding boundaries. For example:

- Lesson 2, Part VI, Elaborate, Step #31: "Tell students this model does not need to be accurate (they do not need to draw a billion dots), but it should indicate their understanding of the differences by showing room 215 fountain has 2 parts in the same volume that room 200 has in 24 parts (or 1 part for room 215 to 12 parts for room 200)" (TG, page 5.2.12).

- Lesson 3, Part I, Explore 1, Step #15, Teacher Note: "If you ask students to write, rather than talk about their responses to the question, you can assess prior knowledge of the properties of matter that were taught in second grade. Student misconceptions regarding magnetism can also be assessed at this point" (TG, page 5.3.8).
- Lesson 3, Part I, Explore 1, Step #21, Teacher Note: "When describing the term weight, do not include any discussion of mass. Instead refer to weight as the heaviness an object has compared to other objects" (TG, page 5.3.10).
- Lesson 4, Part I, Explore 1, Step #5, Teacher Note: "Students are not expected to know boiling points at this grade level, but they should be able to state that there are properties of water and sugar (or other matter) that result in the materials evaporating at different temperatures" (TG, page 5.4.6).

Suggestions for Improvement

- Consider clarifying student understanding about the indicator used in relation to sugar and salt.
- Consider incorporating a safety note cautioning educators to clarify with students that they are participating in a simulation and that significantly contaminated water cannot be safely purified with a handmade filter using common items.

II.E. DIFFERENTIATED INSTRUCTION

Provides guidance for teachers to support differentiated instruction by including:

i. Supportive ways to access instruction, including appropriate linguistic, visual, and kinesthetic engagement opportunities that are essential for effective science and engineering learning and particularly beneficial for multilingual learners and students with disabilities.

ii. Extra support (e.g., phenomena, representations, tasks) for students who are struggling to meet the targeted expectations.

iii. Extensions for students with high interest or who have already met the performance expectations to develop deeper understanding of the practices, disciplinary core ideas, and crosscutting concepts.

Rating for Criterion II.E. Differentiated Instruction	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials provide guidance for teachers to support differentiated instruction because suggestions are highlighted for addressing the needs of a variety of learners. However, supports are inconsistent and rarely provided to support student learning of CCCs.

Supports are provided for using multiple modalities to express student thinking. For example:

- Lesson 1, Part I, Engage, Step #3, Teacher Note: "For reluctant writers, suggest students draw a picture of their experience/memory. If a student seems stuck, ask if they would drink water from a puddle outside the classroom, a lake, or a stream. Is the water safe to drink? Why or why not?" (TG, page 5.1.4).
- Lesson 4, Part II, Explore 2, Step #18: "Differentiation strategy: If students are familiar with the crosscutting concept Systems and System Models, then a sketch of their process can be drawn as a system, the components labeled, and the interactions described instead of writing out the specifics for each part of their system" (TG, page 5.4.11).

Some extensions are provided for students with high interest. For example:

- Lesson 1, Part III, Engage, Step #18, Teacher Note: "Water protection and preservation are not addressed explicitly in this learning sequence, but these questions help students realize problems that may exist within the larger system. These issues within the system can be added as an extension or differentiation strategy at the end of the learning sequence" (TG, page 5.1.9). It is unclear what about "these issues" can be added as an extension or differentiation strategy.
- Lesson 3, Part I, Explain 1, Step #24, Teacher Note: "A Frayer Model is completed by writing several examples and non-examples of the vocabulary term being defined…Differentiation

strategy: Advanced students can create a Frayer Model for the term *weight* while the teacher works with students who need more guidance on magnetism" (TG, page 5.3.10).

- Lesson 3, Part II, Explore 2, Step #35, Teacher Note: "Differentiation strategy: Allow students to create their own data tables" (TG, page 5.3.13). Although not stated, this is likely for more advanced students.
- Lesson 4, Part I, Engage, Step #3, Teacher Note: "Focus on the 'cleaning the water' section of the Design Solutions Question Board. Possible Extension: Students may have questions about preventing contamination of water. If so, add that category to the Design Solutions Question Board. If students do not yet have these questions, it is likely that these sorts of questions will emerge soon, at which point the category can be added. Water protection and preservation are not addressed in this learning sequence, but it can be added as an extension or differentiation strategy at the end of the sequence; it addresses 5-ESS3-1" (TG, page 5.4.5). An idea for the focus topic of an extension is suggested, but details are not provided to support educators in facilitating students with high interest or those that have already reached proficiency in the targeted learning goals.

Supports are provided for struggling students. For example:

- Lesson 2, Part II, Explore 1, Step #4, Teacher Note: "Differentiation strategy: Based on the scaffolding needs of the students, you may need to provide a template for the model which includes the glasses already drawn and a checklist of the items to be included on the model (shown in the bulleted list above)" (TG, page 5.2.6). Materials do not provide support on how to identify needs for modeling, nor is there guidance about the progression of student expectation related to the SEP at this grade band to help educators anticipate needs.

Supports are provided for multilingual students and students who read below grade level. For example:

- Lesson 2, Part IV, Explore 3, Step #23, Teacher Note: "Differentiation strategy: Struggling readers can be provided more direct instruction on finding evidence as the article is read aloud to them. A discussion of key vocabulary and phrases to look for that suggest 'matter is too small to be seen' can occur prior to reading; for example: cannot be seen, no color difference, no taste" (TG, page 5.2.10).
- Lesson 3, Part I, Explore 1, Step #16, Teacher Note: "Use one of these sentence frames as a discussion scaffold if needed: One property that these items can be sorted/classified by is _____. For example, the _____ can be classified as a(n) _____. Another property that these items can be sorted by is _____" (TG, page 5.3.8).

<u>Suggestions for Improvement</u>

- Consider providing more detailed and consistent educator guidance, as well as student supports (tools) and individualized strategies to ensure that all students — including students with disabilities or Individualized Education Programs (IEPs) — can engage with all targeted learning goals, learning tasks, and assessments in all three dimensions.

II.F. TEACHER SUPPORT FOR UNIT COHERENCE

Supports teachers in facilitating coherent student learning experiences over time by:

i. Providing strategies for linking student engagement across lessons (e.g. cultivating new student questions at the end of a lesson in a way that leads to future lessons, helping students connect related problems and phenomena across lessons, etc.).

ii. Providing strategies for ensuring student sense-making and/or problem-solving is linked to learning in all three dimensions.

Rating for Criterion II.F. Teacher Support for Unit Coherence	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials support teachers in facilitating coherent student learning experiences over time because explicit guidance is provided for educators to understand the flow of the learning sequence. However, some lessons have missed opportunities to link student engagement between lessons; for example, teacher guidance is not provided to modify the discussion at the beginning of an activity to ensure that students see how it connects to what they just decided to do in the previous activity (see related evidence in Criterion I.D).

The unit materials contain storyline descriptions for educators that are intended to communicate the connections between lessons as well as the connections between individual lessons and the phenomenon and problem. Related evidence includes:

- Introduction: "Learning Sequence Narrative: The Learning Sequence narrative briefly describes what students do in each lesson and links the learning between the lessons as a conceptual storyline. As students progress through the learning sequence, they are making sense of designing a solution to the problem. The identified problem for this learning sequence is: Water collected from a town may be contaminated. The town officials are requesting help to design a process that will identify the particles in the water and then clean the water. Students begin thinking about a solution to the problem by developing models of the town water samples and exploring the properties of the observable and unobservable matter in those samples. The properties students explore include magnetism, conducting electricity, solubility, and the quantities of matter in terms of weight and volume, Students then design a solution and evaluate the efficiency of processes to clean the water samples" (TG, page 5.0.7).
- Lesson 1, Storyline Link: "This learning sequence targets engineering design; the design challenge is to design a process that will identify the particles in the water and clean the town's water supply. This lesson is the first in the sequence and is designed to activate students' prior experience with contaminated water, elicit their questions about contamination from observations of a video and actual water samples, and generate investigation questions that will drive their learning through the next set of lessons. This lesson introduces the identified

problem: Water collected from a town may be contaminated. The town officials are requesting help to design a process that will identify the particles in the water and then clean the water. In order to do this, students, throughout the learning sequence, will build on their prior knowledge that matter is made of particles too small to be seen, but even so, the matter can be detected by other means. In Lesson 2 Finding impurities in Water, students will investigate how the quantity of matter in the water impacts its contamination level" (TG, page 5.1.2).

- Lesson 2, Storyline Link: "In the previous lesson, students were introduced to the problem that the town water might be contaminated. Students created a model of possible contaminated water and created questions to help them understand more about the contamination and to generate an engineering design to fix the contamination. In this lesson, students use their investigation questions to identify the presence and amount of contamination, reinforcing the idea that articles that are too small to be seen exist in the water. They continue to revise their models and create new ones to explain their understanding. Students also review and add to their design questions about ways to clean the water. In the next lesson students explore their investigative questions about the properties of the material. This will assist them in designing their plans for cleaning the town water" (TG, page 5.2.2). There is no evidence in Lesson 3 to support that student work and learning is motivated by student-generated questions. To the contrary, Lesson 3, Part I, Engage, Step #5 states that the educator should "Ask: 'I wonder how we can find out if there is iron in the cereal. I wonder if it is really metal or if there is some other kind of iron?" (TG, page 5.3.6). The lesson continues in Part I, Explore 1, Step #13 with educators prompted to "Continue the discussion asking, 'How can knowing the properties of different types of matter help us solve our problem of identifying what's in the water sample jars?'" (TG, page 5.3.7).
- Lesson 3, Storyline Link: "In the last lesson, students used their investigation questions to identify the presence and amount of contamination, reinforcing the idea that particles that are too small to be seen still exist in the water. They continued to revise models and create new ones to explain their understanding. Students also reviewed and added to their design questions about how to clean the water. The next question they will explore is 'How can the properties of matter help us know what is in the water?' This lesson centers on students' understanding that properties such as magnetism and solubility of matter can be used to identify unknown matter, and those properties can be useful in solving problems such as separating matter into categories or identification. By using the properties of matter, students can begin to plan a design to solve the problem of separating and identifying the matter in the Town Water Samples. In the next lesson, students will create a plan to separate substances using the properties of magnetism or a substance's ability to dissolve into water" (TG, page 5.3.2).
- Lesson 3: The teacher is guided to help students explicitly connect their prior understanding of magnetism and properties of matter to their design challenge (TG, page 5.3.7).
- Lesson 4, Storyline Link: "In the last lesson, students learned new properties of matter (magnetism, electrical conductivity, weight, and solubility) and continued to use their knowledge of matter and the various properties of matter to identify substances…This lesson centers on students investigating new properties of matter evaporation and filtration to gather data and evidence. They use this evidence to plan a design solution for identifying and removing

the unwanted materials from the town water samples. Students define criteria and constraints of the water problem as part of the engineering design. In the next lesson, students will use their possible design solutions to identify and separate matter from the water contained in the town water samples" (TG, page 5.4.2).

- Lesson 4: The teacher is guided to help students explicitly connect their learning to the problem solving: "Discuss the processes of filtration and evaporation in the article and address how the new information could be helpful in developing the plan to clean the water in the jars" (TG, page 5.4.6).
- Lesson 5, Storyline Link: "In the last lesson, students investigated filtration and evaporation as two processes that could clean the town water samples. Students began to use an engineering design process which included defining criteria and constraints. This lesson focuses on students using all the information they have gathered regarding the properties of matter to build a process or system to identify and separate the materials in a town water sample. Students will also evaluate their processes or success in meeting the criteria and constraints and compare their results to the results of other teams' processes. By the end of this lesson, students will be closer to understanding the anchoring phenomenon that sewage water can be processed so that it is drinkable" (TG, page 5.5.2).
- Lesson 5: The teacher is guided to help students connect their learning to sense-making: "Ask students to reflect in their science notebook how understanding the properties of matter and identification of matter helps them understand the anchoring phenomenon that sewage water can be made drinkable" (TG, page 5.5.9).

Guidance is frequently provided for educators to elicit student questions, but those questions are not consistently curated and leveraged to connect to subsequent lessons. Sometimes questions prescribed by the educator are used to connect learning between lessons. Related evidence includes:

- There are three structures identified throughout the unit: a Class Question Board, a Testable Question Board (mentioned but never returned to), and a Design Solutions Question Board. Additionally, educators are prompted to have students help them categorize the questions on the Class Discussion Board during Lesson 1, but no explicit guidance is given at the time to suggest categories, or the purpose of categorization. These categories are later referenced by specific names throughout the remainder of the learning sequence. Questions on the Design Solutions Question Board are not initially asked to be categorized, but later expected to be.
- Lesson 1, Part III, Engage, Step #16: A Testable Questions chart is created: "At this point, move testable questions that require an experiment to another chart labeled Testable Questions" (TG, page 5.1.8). However, it is never again revisited or leveraged in the unit.
- Lesson 1, Part III, Engage, Step #14: "Ask table groups to share 1–2 new wonderings (questions) after they listened to the information from the police and add the questions to the Class Question Board. Ask the groups to add their sticky note questions to the appropriate categories" (TG, page 5.1.8). This direction is redundant from Lesson 1, Part II, Engage, Step #13 and does not leverage the questions already proposed in the in the preceding portion of the lesson.
- Lesson 1, Part III, Engage, Step #18: "Connect the students' questions to what they will investigate in the upcoming lessons: Quantity of matter in the water (Lesson 2: Finding

Impurities in Water) How do we know if the water is clean and safe to drink? How much matter is in the water? Is any amount of contaminating matter safe? Type of matter in the water (Lesson 3: Properties of Matter) How do we know what type of matter is in the jars? Do any jars have no contamination? How do we know if there is other matter in the jar? Cleaning the water (Lesson 4: Cleaning Water and Lesson 5: Separating Mixtures) How can the contaminating matter be removed from the water? How can we make the water clean or safe to drink? Are there different ways to clean the water?" (TG, page 5.1.9). This direction prompts educators to explicitly spell out for students not only the sequence in which concepts will be presented and learned, but also the questions that will frame the learning.

- Lesson 2, Part I, Engage, Step #3: "Review the Design Solutions Question Board categories from Lesson 1. Remind students that their questions are driving the lessons with the goal to develop a plan to help the town clean the water in the sample jars. Read several of the questions listed in the category related to determining how much matter is in the jar water. For example: How do we know if the water is clean and safe to drink? How much matter is in the water? Is any amount of contaminating matter safe to drink?" (TG, page 5.2.5). No categories were suggested related to the Design Solutions Question Board. Lesson 1, Part III, Engage, Step #18 implies question categories, but only for the Class Question Board.
- Lesson 3, Part I, Engage, Step #12: "Connect this activity to the Class Question Board item that asks how we can identify what matter is in the Town Water Samples. Ask students to respond to this prompt in their science notebook 'How can what we just did with the cereal help us to determine if any iron is in each of the Town Water Samples?'" (TG, page 5.3.7).
- Lesson 3, Part II, Elaborate/Evaluate, Step #46: The teacher is directed to identify from the Class Question Board a question similar to "How can we remove the contaminating matter from the water in the jars?" Small groups are asked to discuss the question, share with the class, and add new questions to the Class Question Board or delete questions (TG, page 5.3.15). It is unclear why educators are prompted to delete them instead of returning to addressing existing questions with new understanding in order to record evidence and answers.

As a minor note, the overview description of an anchoring phenomenon (Intro page 6) might seem to conflict somewhat with the description of the learning sequence problem to solve (Intro page 7), since each is written as if it is the (sole) major driving factor of the learning sequence. This might be a little confusing to users.

Suggestions for Improvement

Consider including explicit educator guidance to help students see smooth and coherent connections between all lessons and activities. A clarification and streamlining of the structures used to collect and maintain student questions might be helpful in creating these connections.

II.G. SCAFFOLDED DIFFERENTIATION OVER TIME

Provides supports to help students engage in the practices as needed and gradually adjusts supports over time so that students are increasingly responsible for making sense of phenomena and/or designing solutions to problems.

Rating for Criterion II.G. Scaffolded Differentiation Over Time	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials support teachers in helping students engage in the practices as needed and gradually adjust supports over time because some SEP elements are used more than once in the unit with some change in scaffolding over time, although this only happens for a small percentage of the claimed SEP elements.

Student learning and proficiency progressions are supported for parts of three SEPs as described below:

Asking Questions:

- Scaffolding is provided in Lesson 1 for asking questions that can be investigated, and a full release to student independence is expected starting in and continuing after Lesson 2.
    - Lesson 1, Part II, Engage, Step #11, Teacher Note: “If students need scaffolding on asking questions, ask them what observations will reveal more information. You want to lead students to ask questions that can be investigated” (TG, page 5.1.6).
    - Lesson 1, Part III, Engage, Step #13: “Review the Class Question Board with the class, then ask table groups to select their top three questions that they think are the best investigation questions. Use these prompts to help students identify the investigation questions: What questions can be answered using data from investigations? What type of question would result in learning new information about the potentially dirty water? Which questions are focused? How might we investigate the question? (Do we have the resources in our classroom to do that?) If your question is a yes/no question, how can you change it so that it asks for information (data)?” (TG, page 5.1.8).
    - Lesson 2, Part II, Explore 1, Step #10: Students are expected to ask questions that can be investigated without scaffolds: “Then facilitate a student-led class discussion about the differences between the two glasses of water and questions the students have that could be investigated to help them identify the matter in the glasses. Write those questions on the Class Question Board” (TG, page 5.2.7).

Developing and Using Models:

- The Lesson 1 handout, 5.1.H1, scaffolds model drawing for students by providing written prompts and image outlines to support drawing (TG, page 5.1.12).
- Lesson 2, Part II, Explore 1, Step #4: Students are expected to model without scaffolds, “Show the two glasses of water, one marked A and one marked B, that you prepared in the Advance

Preparation. Ask student pairs to use what they know about making models to draw in their science notebook a model of what they see in the two glasses" (TG, page 5.2.5), but the teacher note is provided, "Differentiation strategy: Based on the scaffolding needs of the students, you may need to provide a template for the model which includes the glasses already drawn and a checklist of the items to be included on the model" (TG, page 5.2.6).

Analyzing and Interpreting Data

- For Lesson 2, Handout 5.2.H2 students are asked to complete the following writing prompts to compare their results so to evaluate their processes used to complete the parts per billion task: "Our group results are similar to__ because__. Our group results are different from__ because__. What are some reasons for similarities and differences in data?" (TG, page 5.2.23).
- Lesson 3, Part I, Explore 1, Step #17: "Have teams review their sorting, asking them to compare and contrast their data to find patterns. Ask students to record their ideas in their science notebook" (TG, page 5.3.8).
- Lesson 5, Explain 2, Step #17: Students work individually to compare and contrast data: "Ask students to individually write in their science notebook reflecting on the different design processes created by their peers and the data showing how each design worked in separating the various matter in the water samples" (TG, page 5.5.8).

Suggestions for Improvement

The focus of this criterion is on helping ensure that students have increasing ownership and proficiency in the claimed, targeted SEPs over time. For SEPs that are learning goals, consider having educator-provided scaffolding decrease over the course of the unit.

- This could include but is not limited to the use of scaffolds early on that are not used later, group work early on that moves to individual work later, and tasks or items used to engage students in SEPs that increase in complexity by incorporating additional sub-sections of complex SEP elements (e.g., early on only expecting students to use part of an element and later expecting the full element).
- Prioritizing, clarifying, and/or eliminating SEP elements claimed as targets may help with this. The number and variety of claimed SEPs and SEP elements (23 elements over the course of five lessons) is not currently proportionate to the provided opportunities during which students can engage with SEPs, so educator release due to progressing student independence for each SEP element may not seem feasible.

OVERALL CATEGORY II SCORE: 2 (0, 1, 2, 3)	
Unit Scoring Guide – Category II	
Criteria A-G	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria
2	Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A
1	Adequate evidence for at least three criteria in the category
0	Adequate evidence for no more than two criteria in the category

CATEGORY III

MONITORING NGSS STUDENT PROGRESS

III.A. MONITORING 3D STUDENT PERFORMANCES

III.B. FORMATIVE

III.C. SCORING GUIDANCE

III.D. UNBIASED TASK/ITEMS

III.E. COHERENT ASSESSMENT SYSTEM

III.F. OPPORTUNITY TO LEARN

III.A. MONITORING 3D STUDENT PERFORMANCES

Elicits direct, observable evidence of three-dimensional learning; students are using practices with core ideas and crosscutting concepts to make sense of phenomena and/or to design solutions.

Rating for Criterion III.A. Monitoring 3D Student Performances	Inadequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found inadequate evidence that the materials elicit direct, observable evidence of students using practices with core ideas and crosscutting concepts to make sense of phenomena and design solutions. Many student artifacts require grade-appropriate elements of more than one dimension to be used together. However, the exact assessment targets are unclear and a large percentage of claimed elements in the learning sequence do not seem to be assessed.

Student artifacts are collected from all students in a variety of forms throughout the learning sequence including drawn models, notebook writing, worksheets, data collection, exit slips, and posters. Most of the assessments are at least two dimensional and in service of sense-making or problem solving. Related evidence includes:

- Lesson 4, Part I, Explain 1, Step #7: "Students write a response on 5.4.H2: Exit Ticket for each of these questions: How does understanding properties of matter help us use filtration to identify materials? How did the crystals and residue form in the cups that were left out from the last lesson? Predict what would happen if a mixture of sand and water was left to evaporate. Based on your learning so far, what suggestions would you give city leaders regarding the neighboring town's drinking water problem?" (TG, page 5.4.8).
- Lesson 4, Part II, Elaborate/Evaluate, Step #25: "Have students individually complete 5.4.H4: Sugar Water to demonstrate their understanding of: a small quantity of matter (sugar) existing in a larger quantity of other matter (water) how to draw a model demonstrating their understanding designing a process to provide evidence" (TG, page 5.4.12).
- Lesson 5, Evaluate, Step #23: "Have students work in pairs to discuss what they learned from separating the mixture in Town Water Sample #2. Based on that information, they must develop an explanation that describes how a water filter works. They should include their understanding of: particle size, the properties of materials that are used to identify them, the scale of the filter, water, and contaminants" (TG, page 5.5.8).
- Lesson 5, Evaluate, Step #24: "Have each pair make a poster to display outside the classroom, so that others can understand how a water filter works. Hang the posters around the school to make other students aware that contaminated water can be cleaned" (TG, page 5.5.9). The description and criteria for this artifact are not detailed enough to know if it would serve as a three-dimensional example.
- Lesson 5, Evaluate, Step #25: "Ask students to reflect in their science notebook how understanding the properties of matter and identification of matter helps them understand the

anchoring phenomenon that sewage water can be made drinkable. They should state that water filtration makes sewage water safe" (TG, page 5.5.9). If the last phrase is the only expectation for student response, it is very limited and does not encompass aspects of the three dimensions.

Overall, there are significant mismatches between the learning goals claimed and those assessed in the materials. For example, there is some associated evidence of assessment for only about 2/3 of the 23 SEP elements claimed and only half of the six claimed CCC elements.

Suggestions for Improvement

- Consider proportionally matching assessments with the claimed learning goals or prioritizing and identifying key learning targets to which assessment opportunities are aligned. This could include reducing assessment claims and providing additional supports to assess student use of grade level-appropriate elements (or partial elements). For example, the materials claim 23 SEP elements. It may be difficult to effectively measure student performance in all 23 SEP elements over the course of five lessons.
- Consider increasing the opportunities to elicit direct, observable student artifacts aligned to three-dimensional learning targets and including guidance in teacher lesson plans on how, when, and why educators can use student artifacts to monitor learning.
- The unit includes great support for collaborative group work and discussion. Consider how a selection of these group work opportunities could be formalized in such a way that educators are able to elicit information from all students to appropriately monitor individual students' progress for all learning targets in each dimension.
- Revision of the communicated expectations for the Lesson 5, Evaluate, Step #25 task could help to clarify how students are expected to draw on understanding from all three dimensions.

III.B. FORMATIVE

Embeds formative assessment processes throughout that evaluate student learning to inform instruction.

Rating for Criterion III.B. Formative	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials embed formative assessment processes throughout that evaluate student learning and inform instruction because the materials regularly call out formative assessment opportunities, with some being multi-dimensional and including (limited) guidance on how to interpret student responses. However, there is a mismatch between the claimed learning targets in each of the three dimensions and what is assessed throughout the unit materials, and suggestions for how to adjust instruction after formative assessment are not regularly provided.

The introductory document states that "Throughout the sequence, a flag (▶) denotes formative assessment opportunities where instruction may change in response to students' level of understanding and making sense of the problem" (TG, page 5.0.10). However, few formative assessment opportunities include guidance for next steps that are suggested to be taken based on individual performance or response. Related evidence includes:

- Lesson 1, Part II, Engage, Step #13, Teacher Note: "After the lesson, collect 5.1.H1: Town Water Samples as a formative assessment to gather information to direct future lessons and provide students with feedback on the expectations for drawing a model. Assess students' application of PS1.A to see if they can use prior knowledge about the particulate nature of matter. If a student model does not include other particles such as sugar, salt, iron, etc. for at least jars #1, #2, and #3, remind them of the story and the samples of these materials they looked at" (TG, page 5.1.8). Additional guidance about how to use this assessment to direct future lessons is not provided.
- Lesson 2, Part II, Explore 1, Step #4: Marked with a red flag "Show the two glasses of water, one marked A and one marked B, that you prepared in the Advance Preparation. Ask student pairs to use what they know about making models to draw in their science notebook a model of what they see in the two glasses. As students draw their models, look for them to depict these ideas: a single shape that represents a water particle, particles loosely drawn in the glass to represent a liquid, parts labeled" (TG, page 5.2.5). Specific guidance about how to use this assessment to direct the remainder of the lesson or future lessons is not provided.
- Lesson 2, Part VI, Elaborate, Step #31: "Have students return to 5.2.H1: Analyze This and review the data or School B only. To assess students on their understanding of scale, proportion, and quantity, ask students to use a whiteboard or a piece of chart paper to draw one particle model of a glass of water coming from the drinking fountain at school B for room 215 and another particle model for the drinking fountain at school B by the door for room 200. Tell students this model does not need to be accurate (they do not need to draw a billion dots), but it should indicate their understanding of the differences by showing room 215 fountain has 2 parts in the same volume that room 200 has in 24 parts (or part for room 215 to 12 parts for room 200)" (TG, page 5.2.12). Specific guidance is not provided about how an educator should proceed instructionally if students do not meet the minimum expectations expressed.
- Lesson 2, Part VII, Evaluate, Step #38, Teacher Note: "This is an opportunity for brainstorming and creative thinking by students to reflect on the difficulty of quantifying extremely small values. It also provides an opportunity to formatively assess student understanding of ppb. All answers are acceptable" (TG, page 5.2.14).
- Lesson 3, Part I, Explore 1, Step #17, Teacher Note: "Formative assessment: Students are responding to how they sorted based on the patterns of properties. Students should include magnetism and patterns of similarities of items" (TG, page 5.3.9).

- Lesson 3, Part I, Explore 1, Step #20, Teacher Note: "This activity can be a quick, whole-group formative assessment of the properties of matter or PS1.A (e.g., not magnetic, conducts heat, conducts electricity, metal" (TG, page 5.3.9).
- Lesson 3, Part I, Explain 1, Step #23: Marked with a red flag: "Circulate while student teams discuss and describe how they sorted the items and their reasons or sorting the items the way they did. Based on your assessment of student discussions during the team sorts, provide feedback to the class. You might need to explain the new properties including weight (the heaviness an object has compared to other objects) and magnetism (the ability of some metal objects to be attracted to a magnetic force)" (TG, page 5.3.10).
- Lesson 3, Part I, Explain 1, Step #26: Marked with a red flag "Hand out 5.3.H3: Exit Ticket. Ask students to complete this prompt: 'What properties did you use to sort the materials that were collected in your properties table?' Collect 5.3.H3: Exit Ticket" with the Teacher Note: "Review the exit slips for student understanding before beginning Explore 2 (e.g., did they relate the idea of the small particles of iron to small weight/quantity?). Adjust Explore 2 accordingly" (TG, page 5.3.11).
- Lesson 3, Part II, Explain 2, Step #43: Marked with a red flag "Distribute another copy of 5.3.H2: Frayer Model, and have students write a term dissolve in the central oval and complete the model. Ask partners to share their ideas. Listen for how students talk about dissolving. You want them to realize that that they know it doesn't disappear, it just becomes invisible because matter is made of particles too small to be seen" (TG, page 5.3.14). Specific guidance is not provided about how an educator should proceed instructionally if student pairs do not express the desired understanding.
- Lesson 4, Part I, Explore 1a, Teacher Note: "If students have difficulty understanding evaporation, have students create 'rock candy' to develop a connection to the process" (TG, page 5.4.7).
- Lesson 4, Part II, Elaborate, Evaluate, Step #27: "Collect 5.4.H4: Sugar Water and review the student responses. The responses will provide you with information as to what the students still do not understand about mixtures" (TG, page 5.4.13). Specific guidance about how to use this information to direct or apply to future lessons is not provided.
- Lesson 5, Explain 2, Step #19: Marked with a red flag "(Self-assessment) Ask table groups to reflect on their process for their design by referring to 5.4.H5: Rubric (from Lesson 4: Cleaning Water). Ask them to reflect on the last four components (planning and carrying out investigations, analyzing and interpreting data, using mathematics and computational thinking, and designing solutions" (TG, page 5.5.8).

Suggestions for Improvement

- Ideally, most formative assessment opportunities would be accompanied by clear guidance for the educator about how to interpret student responses, as well as how to modify instruction based on varied student responses. For example, guidance could describe how the next activity could shift if some students aren't quite proficient in applying a CCC element or how to modify instruction if formative assessment reveals that students are already proficient with the targeted learning (e.g., providing extensions).

- Most formative assessments would ideally be tied to grade-appropriate elements of at least one of the three dimensions, with cumulative opportunities across the unit addressing all three dimensions. Providing opportunities for grade band appropriate, multi-dimensional formative assessments would also be helpful.

III.C. SCORING GUIDANCE

Includes aligned rubrics and scoring guidelines that provide guidance for interpreting student performance along the three dimensions to support teachers in (a) planning instruction and (b) providing ongoing feedback to students.

Rating for Criterion III.C. Scoring Guidance	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials include an aligned rubric and scoring guidelines that help the educator interpret student performance.

Expected Student Responses (ESRs) are offered consistently throughout the materials when discourse is referenced, as well as for some written tasks. Related evidence includes:

- In Lessons 1 and 2 examples of what student models of water samples might look like are provided. However, the expectation shown in Lesson 1 indicates that students would need to come to this unit having reached proficiency in PE 5-PS1-1: Develop a model to describe that matter is made of particles too small to be seen. Lesson 2 claims that students are working toward this PE.
- Lesson 1, Part I, Engage, Step #4: “Ask students to share their response with their table group and then have a representative from several groups share with the whole class. Expected Student Responses (ESRs): I don’t want to get sick; I might get a stomachache; it could rot my teeth; my mom would be really mad” (TG, page 5.1.5).
- Lesson 3, Part II, Explain 2, Step #41: “Put these questions on the board and have students discuss each question in their table groups using their data from 5.3.H4: Mixing Matter Observations. ‘What did you notice?’ ESR: Some matter ‘disappeared,’ some did not. ‘Did the matter really disappear? What is your evidence?’ ESRs: It looked like it disappeared, but the weight of the water and matter stayed the same, so it still had to be there. ‘Which matter dissolved in the water? What is your evidence?’” No ESRs are provided. “‘Which did not dissolve? What is your evidence?’” No ESRs are provided. “‘What do you think causes some matter to dissolve in water and other matter to not dissolve?” (The purpose of this question is to get students to look for a pattern that might be helpful for their designed solution and tests to separate the water and contaminants in the town samples.)” (TG, page 5.3.14).

- Lesson 4, Part II, Explore 2, Step #11: "Distribute 5.4.H3: Environmental Engineer Design Plan and have students record the problem in the box labeled #1. If needed, students can be provided with this sentence stem: ____ needs a way to _____ so that _____. ESR: The town needs a way to identify matter in the water so that the contaminants can be separated from the water, making the water safe for drinking" (TG, page 5.4.11).
- Lesson 4, Part II, Explore 2, Step #17: "After groups have time to brainstorm, have a whole-class discussion of the appropriate types of data to collect. You may want to discuss the benefits of conducting multiple trials in an experiment. Ask, 'How can we use math to help describe and measure this scale of filtration?' Facilitate a class discussion on the importance of conducting multiple trials to validate results. ESRs: We can collect data on the amount of water going into the filter and how much is coming out. We can compare the color before and after the filtration process. We can repeat our process multiple times." The provided expected student responses (ESRs) are assumed to be the exemplar but those provided do not include an explicit connection between filtration and mathematics, specifically how the amounts of water relate to the degree to which (scale) the water is filtered (TG, page 5.4.11).
- Lesson 5, Evaluate, Step #23: "Have students work in pairs to discuss what they learned from separating the mixture in Town Water Sample #2. Based on that information, they must develop an explanation that describes how a water filter works. They should include their understanding of: particle size, the properties of materials that are used to identify them, the scale of the filter, water, and contaminants" (TG, page 5.5.8).
- Student exemplars are not provided for the poster creation tasks.

One rubric, 5.4.H5, is provided for the entirety of the unit. The rubric is not introduced until Lesson 4, Part II, Explain 2, Step #21. The rubric has six rows or criteria. Each rubric criterion is limited to evaluating student performance related to an SEP, and some of the SEPs listed on the rubric are from the middle school grade band. Different criteria of the rubric are used on only two separate occasions, in the last two lessons of the learning sequence:

- Lesson 4: "Hand out 5.4.H5 Rubric and tell students to consider only the first two rows at this time (defining problems and developing and using models)" (TG, page 5.4.12).
- Lesson 5, Explain 2, Step #19: "(Self-assessment) Ask table groups to reflect on their process for their design by referring to 5.4.H5: Rubric (from Lesson 4: Cleaning Water). Ask them to reflect on the last four components (planning and carrying out investigations, analyzing and interpreting data, using mathematics and computational thinking, and designing solutions)" (TG, page 5.5.8).

Suggestions for Improvement

Scoring guidance, whether in the form of aligned rubrics or samples of exemplar student responses, would ideally target all grade-appropriate elements of the dimensions being assessed and provide guidance for how to interpret student performance along all the dimensions as well as their integration and use in sense-making.

- Consider clarifying element-level scoring targets for each major assessment opportunity.

- Consider adding rubrics for student performance related to all three dimensions — for each dimension separately and their use together.
- Consider designing guiding supports or tools to provide educators with enough information to not only facilitate modification of instruction based on student responses, but also provide ongoing targeted feedback to individuals.
- Consider incorporating a range or variety of student responses for major assessment opportunities to clarify the level of performance expected of students. This could include, but is not limited to, including sample student design plans from Lesson 4.

III.D. UNBIASED TASK/ITEMS

Assesses student proficiency using methods, vocabulary, representations, and examples that are accessible and unbiased for all students.

Rating for Criterion III.D. Unbiased Task/Items	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials assess student proficiency using accessible and unbiased methods, vocabulary, representations, and examples because the unit offers opportunities that measure student learning in a variety of ways; over the course of the unit students write, draw, discuss, and verbally present. However, students are not given a choice of modality for expression and some tasks provide limited supports to ensure that all students can successfully understand and complete the expected procedure.

Related evidence includes:

- Lesson 1, Part I, Engage, Step #1: The "Drinking Filtered Sewage Water" video used to present the anchor phenomenon does not include Closed Captioning or a transcript in order to support all students (TG, page 5.1.4).
- Lesson 1, Part I, Engage, Step #5: Instructional guidance outlines for educators, "Have students think about the local water supply chain: 'Where does the local water come from? How might the local water become contaminated? How can we prevent that from happening? How can we fix it? How can we make sure we don't have contaminated water?' Ask students to write their ideas in their science notebook and then share with a partner. Ask a few partners to share" (TG, page 5.1.5). The number of prompts in this direction may be overwhelming without guiding educators to also write these questions for students to see and reference throughout the task. The format(s) in which students should be offering their responses is not clear. Additionally, this is the first time the vocabulary term "contaminated" is introduced. It is presented without any

discussion or student interpretation; the educator is not prompted to connect it back to common discussion of when students may have wondered if water was safe to drink (Step #3).

- Lesson 1, Part II, Engage, Step #9: "Ask students to work in table groups. Distribute 5.1.H1: Town Water Samples and have the groups decide who will observe which jar (TG, page 5.1.5). Educators are not prompted to also provide the directions verbally for completing the task.
- Handout 5.1.H1 – completed in Lesson 1, Part II, Engage, Step #9 – includes the direction "Use your model to explain why you can't see the contaminants" (TG, page 5.1.12) without the whole class ever having established the meaning of "contaminant."
- Lesson 2, Part II, Explore 1, Step #8: "Ask students to enter their ideas in their science notebook, writing cause-and-effect statements. You can provide this sentence frame: The liquid in glass ___ turned ___ (effect) when the indicator was added because ___ while the liquid in glass ___ did not change because ___" (TG, page 5.2.6).
- Lesson 2, Part V, Explain, Step #26: "Distribute 5.2.H2: How Much is One Part per Billion? Have students work in groups of 4 to follow the directions and answer the questions" (TG, page 5.2.11). Educators are not prompted to also provide the directions verbally for completing the task.
- Lesson 2, Part V, Explain, Steps 27–28: A whole group calibration conversation about parts per billion does not take place, instead "After the groups have completed their dilutions, have them share their results with two other groups, comparing and contrasting their models…They now know about parts per billion. Ask pairs to discuss how this information can be added to their model" (TG, page 5.2.12). It is assumed that because the article was provided and students worked with hands-on materials to represent the concept of parts per billion, all students have a full understanding; there is not a culminating discussion about this concept to validate student understanding and clear up misconceptions.
- Lesson 3, Part I, Explain 1, Step #24 and Lesson 3, Part II, Explain 2, Step #43 incorporate a Frayer model graphic organizer to support student comprehension of the vocabulary terms "magnetism" and "dissolve."
- Lesson 4, Part I, Explore 1, Step #4: "Tell students, 'Today, we are going to read about some ways to separate different types of matter that are mixed together. This may be helpful in answering some of your questions and provide more ideas for separating the 'stuff' in the town water samples and ultimately cleaning the sewage water. As we read, draw a star by examples of mixtures that are separated in the real world. Draw a circle around the names of the processes used to separate mixtures. Underline definitions.' Hand out 5.4.H1: Separating Mixtures. Read aloud or have pairs do a shared reading" (TG, page 5.4.6).
- Lesson 4, Toolbox 5.4, Handout, Separating Mixtures: The article provided is above grade-level (TG, page 5.4.15) and an alternative is not provided, although group reading supports are directed.
- Lesson 4, Part II, Explore 2, Step #11: "Distribute 5.4.H3: Environmental Engineer Design Plan and have students record the problem in the box labeled #1. If needed, students can be provided with this sentence stem: ___ needs a way to ___ so that ___" (TG, page 5.4.11).

Suggestions for Improvement

- Consider incorporating reminders for educators to offer a choice of modality (e.g., oral, written, gestures, drawing) during assessment opportunities.
- Consider ensuring that videos used include Closed Captioning and transcripts to increase accessibility.
- Consider ensuring that all text is on grade level or that alternatives are provided.

III.E. COHERENT ASSESSMENT SYSTEM

Includes pre-, formative, summative, and self-assessment measures that assess three-dimensional learning.

Rating for Criterion III.E. Coherent Assessment System	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials include pre-, formative, summative, and self-assessment measures that assess three-dimensional learning because although not all opportunities are clearly labeled as such, the unit contains each of the assessment types listed. However, learning targets are not clearly defined and there are significant inconsistencies between the three-dimensional elements assumed to be learning targets and those that are explicitly assessed throughout the unit.

There are opportunities for generic pre-assessment called out in the unit materials, in the form of eliciting students' general prior, or background knowledge. These opportunities for pre-assessment do not explicitly provide information related to all three dimensions:

- Lesson 1, Procedure, Teacher Note: "This entire lesson is an Engage, designed to elicit students' prior knowledge, gather their wonderings about contaminated water, and encourage them to think about questions they would like to investigate. Student ideas should be recorded, but not challenged or corrected during this lesson" (TG, page 5.1.4).
- Lesson 3, Part II, Explore 2, Step #30, Teacher Note: "This is the students' first exposure to the property of solubility. The purpose of your questions is to elicit student's background knowledge. Hopefully from the questions that students have asked, one relates to mixing. If not, ask the question: 'What would be an important property of matter when making lemonade with fresh lemons? If you want your lemonade sweet, what might you do?' ESR: Add sugar. Ask, 'What must the sugar do to make the lemonade sweet?' ESR: Dissolve in the lemon juice. Ask, 'What does dissolve mean?' Have students discuss with a partner" (TG, page 5.3.12).

Formative assessment opportunities are explicitly identified in the unit materials. See Criterion III.B for related evidence.

There is one example explicitly called out as self-assessment. However, there are other opportunities when students are prompted to individually reflect on their learning. That reflection is focused on communicating what they have learned — not on expressing how think they have performed. For example:

- Lesson 2, Part VII, Evaluate, Steps #36–#37: “Ask students to write in their science notebook at least two things they learned about models in this lesson. For example, over time, how did their beginning model change…Ask students to write in their science notebook at least two things they learned about what might be in the water.” Students are then prompted to share ideas from both prompts with table groups and “pick three ideas that they think will help them in their design and two or three questions they now have” (TG, page 5.2.14).
- Lesson 4, Part II, Elaborate/Evaluate, Step #23: “Ask students to write in their science notebook a reflection on what they have learned about the engineering design process” (TG, page 5.4.12).
- Lesson 5, Explain 2, Step #19: “(Self-assessment) Ask table groups to reflect on their process for their design by referring to 5.4.H5: Rubric (from Lesson 4: Cleaning Water). Ask them to reflect on the last four components (planning and carrying out investigations, analyzing and interpreting data, using mathematics and computational thinking, and designing solutions” (TG, page 5.5.8). The opportunity is communicated as being intended for student groups to reflect together, not for individual reflection.

No summative assessment opportunities are explicitly called out in the unit materials. However, some student performance opportunities could be used as summative assessment.

- The following examples are marked with a red flag in the unit materials, which is explained to be an indicator of formative assessment. However, as these tasks appear at the end of the learning sequence and are not returned to, they might be intended as summative assessment pieces and could be used in that way:
    - Lesson 5, Evaluate, Step #23: “Have students work in pairs to discuss what they learned from separating the mixture in Town Water Sample #2. Based on that information, they must develop an explanation that describes how a water filter works. They should include their understanding of: particle size, the properties of materials that are used to identify them, the scale of the filter, water, and contaminants” (TG, page 5.5.8).
    - Lesson 5, Evaluate, Step #24: “Have each pair make a poster to display outside the classroom, so that others can understand how a water filter works. Hang the posters around the school to make other students aware that contaminated water can be cleaned” (TG, page 5.5.9).
    - Lesson 5, Evaluate, Step #25: “Ask students to reflect in their science notebook how understanding the properties of matter and identification of matter helps them understand the anchoring phenomenon that sewage water can be made drinkable. They should state that water filtration makes sewage water safe” (TG, page 5.5.9).
    - Lesson 5, Evaluate, Step #25, “Use the posters to assess students’ understanding of water filtration” (TG, page 5.5.9).

- As detailed in Criterion I.B, there are mismatches in the grade-level expectations for student use of some SEPs (mathematics and computational thinking). Specially, two elements from the 6–8 grade band are included as criteria on the provided rubric.

Suggestions for Improvement

- Consider including opportunities for pre-assessments that evaluate students' prior knowledge in all three dimensions.
- Consider explicitly identifying revised or added tasks as summative assessment opportunities that connect the learning in all three dimensions from multiple lessons.
- Consider including more than one opportunity for self-assessment of performance on an individual student level.
- Although this criterion does not require that each individual assessment opportunity is three-dimensional, it does ask for evidence that, when considered altogether, the variety of assessment opportunities over the course of the materials provide both the educator and students with information about the degree to which the intended three-dimensional learning targets were accomplished. Consider providing guidance about how the different assessments work together to measure targeted learning in the unit. Educator guidance could include an explanation of the purpose and rationale for how, when, and why student learning is measured across the materials.

III.F. OPPORTUNITY TO LEARN

Provides multiple opportunities for students to demonstrate performance of practices connected with their understanding of disciplinary core ideas and crosscutting concepts and receive feedback.

Rating for Criterion III.F. Opportunity to Learn	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials provide multiple opportunities for students to demonstrate performance of practices connected with their understanding of core ideas and crosscutting concepts because students have some iterative opportunities to demonstrate they have progressed toward and met select targeted learning goals.

Key learning targets are not identified among the abundance of claimed three-dimensional elements, but students have iterative opportunities to demonstrate their understanding related to **Developing and Using Models**, **PS1.A**, and **Scale, Proportion and Quantity**. Related evidence includes:

- Lesson 2, Teacher Note: "There are multiple models used in this lesson. To help keep track of them, this is a list of how they are used. During:…Step 9: Revise the models of cups A and B to include unseen particles identified with the indicator. Step 14: Revise table group models of the town sample jars showing unobservable particles in jars #1, #2, and #3 but not #4. Step 26: Investigate parts per billion (ppb) and develop new models on the worksheet showing parts per billion. Step 27: Revise table group models of the town sample jars now showing parts per billion. Step 30: Assess students' development and use of models for understanding parts per billion. Step 32: Develop models for their evidence in board presentation." (TG, page 5.2.2).
- Lesson 2, Part II, Explore 1, Step #4: Marked with a red flag, which is explained in the material introduction to indicate formative assessment "Show the two glasses of water, one marked A and one marked B, that you prepared in the Advance Preparation. Ask student pairs to use what they know about making models to draw in their science notebook a model of what they see in the two glasses" (TG, page 5.2.5).
- Lesson 2, Part II, Explore 1, Step #9: "Ask students to review their initial model of the two glasses (Step 4) and modify their models to reflect the fact that there is a difference between the matter in the two glasses, which is why the water in the glasses looks different" (TG, page 5.2.7).
- Lesson 2, Part II, Explore 1, Step #14: "Ask students, based on this new information, to revise their models from Lesson 1; Town Water Samples (Step 1 in this lesson) and share with their table group" (TG, page 5.2.7).
- Lesson 2, Part V, Explain, Step #28: "Remind students that they have revised their model from Lesson 1 regarding the 4 jars based on the indicators. They now know about parts per billion. Ask pairs to discuss how this information can be added to their model. Then ask students to revise their model" (TG, page 5.2.12).
- Lesson 2, Part VI, Elaborate, Step #31: "To assess students on their understanding of scale, proportion, and quantity, ask students to use a whiteboard or a piece of chart paper to draw one particle model of a glass of water coming from the drinking fountain at school B for room 215 and another particle model for the drinking fountain at school B by the door of room 200" (TG, page).

Students receive some written feedback on their performance and have at least one explicit opportunity to apply feedback before being assessed. Related evidence includes:

- Lesson 1, Part II, Engage, Step #13, Teacher Note: "After the lesson, collect 5.1.H1: Town Water Samples as a formative assessment to gather information to direct future lessons and provide students with feedback on the expectations for drawing a model. Assess students' application of PS1.A to see if they can use prior knowledge about the particulate nature of matter" (TG, page 5.1.8). Students revisit their models in Lesson 2, but there is not explicit direction to guide students in applying the provided feedback at that time.
- Lesson 2, Part VI, Elaborate, Step #34: "After student pairs have completed their posters, do a gallery walk. Provide students with sticky notes to record feedback on the posters. Facilitate the gallery walk and peer feedback" (TG, page PDF page 44). Students are not given an opportunity to apply this feedback, as the posters are not revisited.

- Lesson 3, Part I, Explain 1, Step #23: "Based on your assessment of student discussions during the team sorts, provide feedback to the class. You might need to explain the new properties including weight (the heaviness an object has compared to other objects) and magnetism (the ability of some metal objects to be attracted to a magnetic force)" (TG, page 5.3.10). There is no clear evidence to explain if and how students apply this feedback.
- Lesson 4, Part 1, Explain 1, Step #9: "Provide feedback to 5.4.H2: Exit Ticket responses and return responses to students by Step 15" (TG, page 5.4.10).
- Lesson 4, Part 2, Explore 2, Step #15: "Students review their exit slip responses and feedback from Step 7 and discuss with their group this prompt: 'Thinking about your lesson experiences, what are some ways that your group can solve this problem and use properties of matter to first separate and then identify the matter?' Have them record the scientific information they know in the box labeled #4 on 5.4.H3: Environmental Engineer Design Plan" (TG, page 5.4.10).
- Lesson 4, Part II, Explain 2, Steps #19–21: "Conduct a table group feedback review of the plans (similar to a gallery walk). One group member remains at the table to present the plan to visiting classmates and receive feedback/questions while other group members visit different groups to provide feedback on their proposed procedures. Direct students to use green sticky notes to identify where the plans are valid and to use yellow sticky notes to write probing questions where the plans need more thought. Circulate, providing feedback and asking probing questions as needed. Hand out 5.4.H5: Rubric and tell students to consider only the first two rows at this time (defining problems and developing and using models). Ask table groups to reconvene, consider their peer feedback, and use the descriptions on the rubric to modify their plan" (TG, page 5.4.12).

Suggestions for Improvement

- Prioritizing and clearly identifying key learning targets would help to focus performance opportunities that can serve as evidence for this criterion.
- Currently, the most apparent two- and three-dimensional iterative student performance opportunities are found in Lesson 2. Consider ensuring that educator and student materials consistently include clear and iterative opportunities for all key learning goals such that students can 1) demonstrate their integration of the dimensions through assessment and 2) receive oral and written feedback and at least one chance to apply the feedback to improve their performance in each key targeted dimension.
- Proportionate to the length of the unit, students currently have limited opportunities to apply feedback to construct new learning that will advance their progress in sense-making and performance related to a set(s) of prioritized three-dimensional learning goals. Consider incorporating regular guidance for educators to prompt students to apply feedback.

OVERALL CATEGORY III SCORE: **2** (0, 1, 2, 3)	
Unit Scoring Guide – Category III	
Criteria A-F	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion
2	Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A
1	Adequate evidence for at least three criteria in the category
0	Adequate evidence for no more than two criteria in the category

SCORING GUIDES

SCORING GUIDES FOR EACH CATEGORY

UNIT SCORING GUIDE – CATEGORY I (CRITERIA A-F)

UNIT SCORING GUIDE – CATEGORY II (CRITERIA A-G)

UNIT SCORING GUIDE – CATEGORY III (CRITERIA A-F)

OVERALL SCORING GUIDE

Scoring Guides for Each Category

Unit Scoring Guide – Category I (Criteria A-F)	
3	At least adequate evidence for all of the unit criteria in the category; extensive evidence for criteria A–C
2	At least some evidence for all unit criteria in Category I (A–F); adequate evidence for criteria A–C
1	Adequate evidence for some criteria in Category I, but inadequate/no evidence for at least one criterion A–C
0	Inadequate (or no) evidence to meet any criteria in Category I (A–F)

Unit Scoring Guide – Category II (Criteria A-G)	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria
2	Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A
1	Adequate evidence for at least three criteria in the category
0	Adequate evidence for no more than two criteria in the category

Unit Scoring Guide – Category III (Criteria A-F)	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion
2	Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A
1	Adequate evidence for at least three criteria in the category
0	Adequate evidence for no more than two criteria in the category

OVERALL SCORING GUIDE	
E	**Example of high quality NGSS design—**High quality design for the NGSS across all three categories of the rubric; a lesson or unit with this rating will still need adjustments for a specific classroom, but the support is there to make this possible; exemplifies most criteria across Categories I, II, & III of the rubric. (total score ~8–9)
E/I	**Example of high quality NGSS design if Improved—**Adequate design for the NGSS, but would benefit from some improvement in one or more categories; most criteria have at least adequate evidence (total score ~6–7)
R	**Revision needed—**Partially designed for the NGSS, but needs significant revision in one or more categories (total ~3–5)
N	**Not ready to review**—Not designed for the NGSS; does not meet criteria (total 0–2)